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RINDERPEST.

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INTRODUCTION.

Since the earliest days of American occupation in the Philippine Islands, rinderpest has claimed the attention of the Government. Its ravages and the progressively increasing losses it had caused to the industrial community, made the subject so important a one in relation to the welfare of the Islands that soon after the organization of the Government a laboratory was established to prepare serum in quantities sufficient to control and, if possible, to eradicate the disease.

In the first years of this work, when non-immune cattle were more easily secured, the opportunities for experimental work on this subject were circumscribed, because of the limited number of workers, the labor entailed in the inoculation of serum animals and in the preparation of serum, the lack of small animals, and of the apparatus for exact experiments. Such work as was done was performed by Jobling and published as a bulletin of this Bureau.[1] Since the organization of the laboratory has been completed, the use of protective inoculation against rinderpest has become more general in the Philippine Islands with the result that it has been difficult to secure animals which were certainly susceptible to this disease and for this second reason the more recent

[1] *Publications Serum Laboratory, Bureau of Government Laboratories* (1903), 4, and *Annual Reports of the Superintendent of Government Laboratories* (1903, 1904), 2, 3.

experimental work has also been curtailed. However, within the past two years two regions in the Islands where cattle are obtainable and where rinderpest has never been observed, have been discovered, namely, Sibuyan Island and the Babuyanes group, and from these islands relatively non-immune animals have been secured for use although, even with these sources of supply, such a large quantity of virulent blood has been required for the production of serum, and the expense of experimentation with cattle has been so great, that the material available for investigation has been small. Nevertheless, some work has been done and some observations made which seem to be of sufficient interest to publish, even though they do not in all ways tend to support the prevalent opinions of the nature of the virus.

ETIOLOGY.

Rinderpest is a widely distributed disease. The original location from which the infection has spread will doubtless never be ascertained, for although European historians of the middle ages mention similar infections, no evidence exists of accurate observations in Asia or Africa in early times. Dieckerhoff's treatise on the history of the disease details what is known in regard to its early occurrence, from which it seems probable that its original home was in the neighborhood of the Black Sea and of the Volga, whence, in the course of years, it was introduced into western Europe; following this, Prussia and the Danube States, Hungary, Croatia, and Italy were attacked; Switzerland, France, Holland, and England remaining free. Later still, with the appearance of railroads and the possibility of rapid transportation, epidemics became common in western Europe, and even England, Germany, and France suffered severely. With the opening of Africa, India, China, and the islands of the Eastern Archipelago, the disease was also observed in this portion of the world and likewise introduced into virgin lands, so that in the many parts of Africa, Asia, certain islands of the Malay Archipelago and most of the Philippine islands, rinderpest is endemic and subject to sudden outbreaks. Climate undoubtedly has little influence on its spread. It does not "give way before cold weather or rain;" it is, Gelach and Littlewood say, more severe in cold and wet weather than in warm and dry and Emes maintains that "it spreads as fast in a cold as in a hot season."

However, moisture surely has an influence on both the viability of the virus and the spread of the infection so that moist or rainy seasons undoubtedly favor the dissemination of the disease.

Gamgee states that age exerts no influence on the susceptibility of an animal to rinderpest and quotes Kersting as saying that, as a result of inoculation, young calves and cows suffer most severely; lean or fat oxen are also badly affected, while animals in moderate condition and at

maturity appear to possess a greater resistance against the disease. These statements do not seem to us to be strictly applicable to cattle in the Philippine Islands. Our experience has taught us that calves are satisfactory subjects for immunization, that milch cows or pregnant animals are less so, and that maturity plays no part in susceptibility. Sex has no influence, if the physical condition of the animal is normal.

Natural resistance, immunity, and susceptibility.—Rinderpest is a disease of cattle and of some allied ruminants.

Man is immune, as are cats, dogs, donkeys, rabbits, guinea pigs, rats, mice, doves, hens, eagles, flamingoes, etc. (Koch, Nicolle and Adil-Bey, Tokishiga, and Tartakowsky.) Sheep and goats are not completely immune, but they have a natural resistance to the disease. However, in these animals as in others, there are racial differences. Both species may show a rise of temperature after experimental inoculation and if the blood is drawn at this time and used to inoculate non-immune cattle, the disease may be produced. (Kolle and Turner, Koch, Theiler and Pitchford, Woronzow.) Sheep may be the means of spreading contagion as Koch and Rogers have stated.

Hogs, camels, antelopes and buffaloes are not so highly susceptible though any of these *may* have the natural or artificial disease.

Natural infection of hogs has been reported from Tonkin and Annam by Clive and Fraimbault. Tartakowsky, in opposition to Refik-Bey, states that camels are sensitive in a certain degree, but that they usually resist the disease or only show mild symptoms. Mense, from his observations, concludes it to be possible that buffaloes may die in large numbers, though Nencki and his fellow-workers say that they are less susceptible than cattle. However, there is not only the difference in immunity of species but there are racial differences of susceptibility and resistance.

In India, Rogers and Lingard found the hill cattle so susceptible that the usual methods of immunization used in the case of animals from the plains were of little avail with the former. These differences, as Sobernheim suggests, may be a result of the endemic occurrence of the disease which, in the course of time, has given rise to incomplete resistance but not to an inborn racial immunity. Kolle has observed in the Soudan, and Pinching and Bitter in Egypt, that the cattle of those localities have a very slight, whereas those of South Africa have a uniform susceptibility.

In the Philippines the variation is so great that, save in a few islands, it can not in advance be stated without further experimental evidence, whether the cattle are susceptible or not. In the Babuyanes group and in Sibuyan, rinderpest has never been experienced, but nevertheless there is an apparent relative resistance to infection in the cattle from these places. The same is true of the animals from certain parts of Australia. The susceptibility of American stock seems to be very great. We have had a very bitter experience with such animals and have found the usual methods of immunization, which are perfectly safe with Philippine cattle, to be extremely dangerous when applied to the former.

In this Bureau we have performed some experimental work in the study of the immunity or susceptibility of laboratory animals.

A series of guinea pigs was inoculated with 0.5 cubic centimeter each of virulent rinderpest blood. Three to four days later they showed increased temperature which continued for twenty days. On the second and third days of the fever, blood was drawn from them and injected into Babuyanes cattle with the result that none of the latter sickened, although all showed a reaction. Later inoculation of the cattle with 5 cubic centimeters of virulent blood showed none to have any appreciable degree of immunity.

The attempts to discover and isolate the organism.—In rinderpest, as in all other of the diseases the etiology of which is not known, many observers have described organisms believed by them to be the active cause of the infection. Thus, Metschnikoff and Gamaleia constantly found in the ulcers of the fourth stomach of sick animals, but not constantly in the blood, bacilli which caused symptoms of rinderpest in guinea pigs and calves. Simpson, Edington, Blin and Carongean, Saccharov, Sadowski, Konew and Trofinow, Semmer, Nencki, Sieber and Wysnikiewicz, and Nencki and Sieber, have described other bacteria, but none of these have been proved to be the causative factor.

The virus of rinderpest.—The etiologic factor is at the present time unknown in spite of conscientious labors of the best workers, extending over a period of many years. However, it is certain that the infecting agent is contained in the secretions of the nasal passages, conjunctivæ, intestines, and in the blood of infected animals, for with any one of these the disease can be reproduced in other individuals. The most certain method of conveying rinderpest is by the injection of infected blood. In using the latter it has been said that 1/500 is just as effectual in producing the disease as is 1 cubic centimeter and that with the former amount, non-immune animals may be killed. (Koch, Kolle, Turner, Nicolle, and others.) From our observations we are able to confirm this dosage only in the cases of cattle which may be called absolute non-immunes, as are the American cattle which we have used. With native animals even from the above-mentioned non-infected islands, this minimal dosage results in a variable incubation period and a diminished intensity of the disease. Some of these cattle, but not all, would probably die if infected with such a minimal dose, but in some instances even 0.1 cubic centimeter of virulent blood will not produce the disease and also the incubation time is noticeably shorter after a dose of 5 than after 1 cubic centimeter, yet the cattle from these Islands are certainly non-immunes. (See cases, Chart 5, No. 931, and Chart 2, No. 907.)

The viability of the virus.—The virus of rinderpest from the blood or the animal secretions mentioned above possesses little viability. Left at a fairly warm room temperature it soon becomes inactive; it retains its activity longer when it is placed on ice, but even under these circumstances the period is not very great. The length of time during which it may be kept in a viable condition varies, according to reports, between three and thirty-two days, but our experience

indicates a limit of from three to six. Kept at 36° to 40° C. it becomes inactive after two days (Theiler); dried blood may remain virulent for four (Koch); glycerine, phenol, and other antiseptic substances, even if used in minute amounts, cause rapid deterioration (Koch, Theiler, Semmer); if it is mixed with other organisms it is quickly killed. The virus resists alkalies longer than it does acids (Nicolle and Adil-Bey); sun destroys it in five minutes (Braddon), but ordinary daylight has little effect (Woronzow and Eckert). Semmer states that material will remain virulent during four to six weeks at ordinary temperatures and that a spleen kept on ice was still capable of causing the disease after six months. At 58° to 60° the virus loses its power in a few seconds, at 52° in half an hour, and at 37° to 45° C. there is a gradual loss. *In vacuo* the deterioration is still more rapid (Nicolle and Adil-Bey). Semmer makes the statement that the virus, heated to 45° to 50° C. during fifteen to thirty minutes, loses its virulence but will give a stable and lasting immunity. On the other hand, Nicolle and Adil-Bey found that blood heated to 60° C. lost its power of carrying the infection and would then not confer immunity. Semmer also states that a temperature of −20° C. brought about an attenuation and Nicolle and Adil-Bey found that blood kept in the cold for two months had lost all virulence.

Dilution with different substances gives varying results. Virulent blood mixed with glycerine becomes inactive (Koch). Nicolle and Adil-Bey found that 1/60 cubic centimeter of virulent blood diluted with 1.5 cubic centimeters of normal saline solution was capable of transmitting the infection, but if a like amount of the former was added to 500 of the latter, the virulence was lost. Virulent blood mixed with normal bile or bile salts retains none of its activity (Adani).

Purely physical processes may also have an effect. It is said that centrifugalized blood does not cause the disease (Kolle) and that defibrinated blood will give a temporary immunity (Rogers).

Experiments on filtering virulent blood.—The results attained by experiments on filtration vary. Nicolle and Adil-Bey state that the organism passes normal Berkefeld and Berkefeld *amincie* filters and *Yersin found that the filtrate obtained by passing rinderpest blood through Chamberland F candles would cause the disease.* On the other hand, Nicolle and Adil-Bey say that the organism does not pass a Chamberland F and Yersin says a Chamberland B gives an inactive filtrate.

Our experiments are as follows:

In 1905, four animals were chosen from a herd of native nonimmunes (Sibuyan). One of these (Chart 1, No. 905) was used as a control and received no blood, but was kept under exactly the same conditions as the others; another (Chart 2, No. 907) was used as a blood control and received 1 cubic centimeter of virulent blood, diluted with 5 cubic centimeters of an 0.8 per cent saline solution; a third (Chart 3, No. 908) was given 5 cubic centimeters of a filtrate from virulent blood, which was collected by passing through a Pasteur-Chamberland F candle, under a pressure of 1.75 kilograms per square centimeter and then diluted with 5 volumes of the same salt solution; a fourth animal (Chart 4, No. 904) received 100 cubic centimenters of the unfiltered blood used for No. 3. The first bull had a normal temperature during twelve days, at the end of which time it was inoculated with 60 cubic centimeters of virulent blood; it then reacted on the third day and was bled to death three days thereafter; at autopsy typical lesions of rinderpest were present. The second animal showed a reaction on the seventh day and a post-mortem made some days later gave convincing proof of the presence of the disease. The third one reacted mildly on the ninth day; three days subsequent thereto 60

cubic centimeters of virulent blood were injected, the result being that a typical reaction was observed on the second day, followed by death two days later. At autopsy, typical, but advanced, lesions were observed. This result seemed to indicate that the disease was caused by the filtrate, so that, had the larger dose of blood not been used, the animal might have recovered. The fourth bull suffered a typical attack of rinderpest.

The conclusion must be drawn from these experiments that small doses of blood or filtrate were not satisfactory with the cattle we used because, as was indicated above, their natural resistance is a great one. For this reason the quantities were increased in later experiments.

In the next series fresh, citrated virulent blood was diluted with five times its own volume of a 0.4 per cent saline solution and then filtered through a new, sterilized Pasteur-Chamberland bougie, under a pressure of 3 kilograms per square centimeter. Two native (Sibuyan) cattle received 30 cubic centimeters each of the filtrate and a control animal was given, subcutaneously, 5 cubic centimeters of the undiluted blood. On the fourth day after inoculation, the control (Chart 5, No. 931) developed the disease; it was subsequently bled to death and the diagnosis established. One of the others (Chart 6, No. 938) had a rise in temperature on the seventh day, was bled to death three days later and the diagnosis of rinderpest confirmed; the second one (Chart 7, No. 937) reacted on the eleventh or twelfth day and developed diarrhœa on the fourth day thereafter, whereupon it was bled and the diagnosis of rinderpest made.

These cases, in view of our other experiences with small amounts of virulent blood and delayed reaction, seem to suggest the virulence of the filtrate. It should be added that the animals were kept under similar conditions in regard to their food and environment but that the control was separated from the other two animals by a distance of approximately two miles and that no one in attendance upon the one had any access to the others. In addition, ten other non-immune cattle which did not contract the disease were stabled with the animals receiving the filtrate, so that their quarters had not become infected.

A third series was as follows: An animal received 30 cubic centimeters of filtrate from a Chamberland I candle (3 kilograms pressure per square centimeter). A reaction was observed on the tenth day but on the third one thereafter the temperature again was normal. After receiving 5 cubic centimeters of virulent blood, this bull showed a typical reaction, developed rinderpest, and died.

Apparently, to judge from these results, the causative agent of the disease may or may not pass through the pores of the Pasteur-Chamberland filter according to the conditions surrounding the experiment. More work on this subject is therefore necessary.

Experiments with defibrinated blood and with filtered bile.—Various experiments have been made with defibrinated blood. Nicolle and Bey have published the statement that filtered, defibrinated blood will not kill and will not give rise to any immunity. Kolle, Turner, and Maberly agree with this view and add that the residue on the filter may be virulent.

Rogers, Maberly, and Verney state that the bile, which of itself may cause the disease (Kolle), when passed through porcelain filters is harmless, and Maberly adds that the residue which is left behind will give a temporary immunity although it will not convey rinderpest. Rogers thinks that the filtered bile will immunize, and Kolle believes that the residue may be infectious. Kolle used samples of bile which were collected on the fourth or fifth days of the disease.

Owing to the results of these experiments, it has generally been concluded that the causative agent of rinderpest can not pass through the pores of the finer porcelain filters. If this be true it must be larger than the organism of peripneumonia and should be visible (Joest). Since it does not appear in the filtrate of blood which is sufficiently diluted with salt solution to destroy the red cells, it has been thought by some that it must be an intra-leucocytic organism (Nicolle and Adil-Bey) and therefore, for the latter reason, it would not pass through the filter.

Modes of conveyance and infection.—It has already been mentioned that all the secretions of a sick animal are capable of causing the disease, but it has also been shown by Burdon-Sanderson and Koch, that although the blood is infectious from the time of the rise in temperature, the secretions are not capable of transmitting rinderpest until the first symptoms of the disease, visible upon inspection, can be noted. This fact, taken in connection with the viability of the virus, at least partially indicates the commonest means of infection, as well as the most usual modes of conveyance.

For many years it has been established that the introduction of infected material into the body of susceptible animals, whether into the blood or tissues or upon the mucous membranes, especially those of the nose and mouth, will cause rinderpest and therefore, freshly infected bedding, utensils, and other implements which have been used while caring for cattle may be dangerous and the disease may also be conveyed on the hands, feet, shoes, or clothing of the attendants. The possibility of transmitting the infection by biting insects is also to be considered because the virus exists in the blood. In the case of very susceptible animals, a very minute amount of blood, when introduced beneath the skin or mucous membrane, would convey the disease.

The length of time during which the virus may remain viable in the soil and in stables is not determined. We know that physical conditions promptly affect the life or activity of this virus, but we also know that stables or pastures may remain dangerous for long periods. The cause of the continuance of this infection in such instances is not known. Whether it be that insects are the important factor or whether the virus remains for a long time in an active condition in the soil is also not clear. This is the more curious, inasmuch as it does not show any evidence of maintaining its viability in laboratory media prepared

either from the waste substances of the body or from mixtures of nutrient materials. I experimented unsuccessfully with media composed to resemble the soil in their chemical constituents; neither was I successful in cultivating an organism capable of causing rinderpest in media containing bile, blood, lecithin, cholesterin, nucleo-proteïds, etc.

SYMPTOMS.

The first apparent symptom of the disease is a rapid rise of temperature, after an incubation period of from three to six days. (Chart 4, No. 904.) This rise almost invariably appears between twenty-four to thirty-six hours before any other symptom is apparent. (Chart 8, No. 1.) The next one, at least in animals from the Philippines, is an injection of the conjunctivæ which is immediately followed by a profuse, sero-purulent discharge from the eyes, often so irritating as to produce excoriation in its course across the face. A varying degree of salivation is also observed, but in Manila, ulcers of the mouth or lips are rarely seen. There is a somewhat profuse, fetid discharge from the nose. With the onset of these symptoms, the appetite diminishes and is finally completely lost; rumination ceases and a rapid diminution in weight follows; the coat is staring. The beginning of the diarrhœa varies; it may be either early or late in the disease; in the usual course it becomes muco-sanguinous, whereas the less virulent forms may run their course almost to the end with no more than an ordinary, very fluid diarrhœa. A peculiar odor of the intestinal discharges is almost characteristic of rinderpest. When the disease is virulent, tenesmus becomes marked and as a result, prolapsus of the rectum is of not uncommon occurrence. Death occurs in collapse, following a fall of temperature; it usually takes place between the sixth and eleventh days of the disease. (See cases, Chart 8, No. 1, and Chart 9, No. 3.)

Abortion follows with regularity in the case of pregnant animals and lactation ceases in milch cows.

The natural disease in Philippine native, non-immune cattle either may show a gradually rising temperature, which reaches its maximum on the second or third day; or a rapid rise to a maximum which is persistent, with the exception of the morning fall, until the lethal drop; or again a sudden advance, followed by a fall and a normal subsequent temperature or, indeed, no well-marked rise at all. So far as our observation goes, there has been no case of the natural disease without diarrhœa, which usually occurs between the fourth and sixth days.

The usual experience with the disease which is artificially produced is a well-marked reaction. However, in some instances this has either been very moderate or even scarcely perceptible; in a few there has been a gradual, rising reaction and in but one or two a sudden, moderate

advance followed by as rapid a fall, after which the temperature only varied within normal limits until it showed the quick, lethal depression. In one such case, no diarrhœa occurred, although an autopsy conclusively demonstrated rinderpest to be present.

Our observations in general may be condensed as follows:

(*a*) In native, susceptible animals pastured on infected ground, rinderpest may appear at any time between the fifth and twenty-third days. (Chart 10, No. 839.)

(*b*) After inoculation with virulent blood, the disease appears between the third and fourth days. (Chart 11, No. 932.)

(*c*) Diarrhœa becomes evident between the fourth and sixth days after the onset of the fever. (Chart 11, 932.)

(*d*) The temperature may vary between 39°.4 and 41°.8.

(*e*) Death is preceded by an abrupt fall of temperature and occurs six to nine days after the reaction. (Chart 10, No. 839.)

MORBID ANATOMY.

There is some difference of opinion in regard to the characteristic lesions of this disease. The European, South African, and Philippine types of rinderpest differ in many points; perhaps it is true that none of the morbid changes are constant and that they may vary in different countries, epidemics, and animals (Walley).

The most constant alterations in the body are emaciation, sero-purulent conjunctivitis, congestion, and general inflammation or ulceration of the gastro-intestinal tract, the latter changes being especially localized in the fourth stomach and pylorus; however, the mucous membrane of the fourth stomach and of the large and small intestine may simply show a diffuse reddening at the summits of the folds. Petechiæ are encountered not only in the gastro-intestinal epithelium but also in the heart, kidneys, liver, and lymphatic glands. Often, the only demonstrable lesions may be those of the fourth stomach, pylorus, and upper part of the small intestine.

In the Philippine Islands, as Jobling has mentioned, we rarely, if ever, encounter the classical cutaneous eruption described in the European disease; it is also true that ulcerations of the nasal and oral mucous membrane are rare, as are those of the patches of Peyer. In place of this condition, a congestion is present in most cases.

The gall bladder is usually distended and contains a thin, greenish bile. The vagina is always congested and the urinary bladder occasionally presents a similar condition.

There are also no discoverable changes in the blood, unless, perhaps, there is a leucopenia of mild degree. In cases in which diarrhœa is severe it is certain that a general concentration exists, and in at least some instances there is not only a relative but also an absolute diminution in the number of white blood cells. The following figures, which

are compiled from the records of Dr. Ruediger, of the Serum Laboratory, serve to illustrate the changes:

Normal cattle:

Average of 27.

$$\frac{\text{Leucocytes}}{\text{Red cells}} = \frac{7,650}{6,043,000} = \frac{1}{790}$$

Rinderpest cattle:

Average of 10.

$$\frac{\text{Leucocytes}}{\text{Red cells}} = \frac{9,820}{9,112,600} = \frac{1}{927}$$

Average of 3 animals which had no diarrhœa.

$$\frac{\text{Leucocytes}}{\text{Red cells}} = \frac{9,500}{7,746,000} = \frac{1}{815}$$

Average of 4 animals with moderate diarrhœa.

$$\frac{\text{Leucocytes}}{\text{Red cells}} = \frac{10,300}{8,112,000} = \frac{1}{737}$$

Average of 3 animals with severe diarrhœa.

$$\frac{\text{Leucocytes}}{\text{Red cells}} = \frac{9,400}{11,813,000} = \frac{1}{1,256}$$

According to Refik-Bey the leucocytes vary as follows: There is an initial rise on the second or third day, a later decrease on the fourth to seventh, and a terminal increase on the seventh to ninth; they are at a minimum on the day of the initial advance in temperature. In most instances the mononuclear cells do not increase at this latter time, but do so steadily after the stage of diminution of the leucocytes is passed. In some instances there is a mononuclear leucopenia. The polymorphic leucocytes usually follow the path of the mononuclears.

In the earier stages of the disease the ulcers in the fourth stomach are preceded by minute, red, hæmorrhagic points which resemble those seen in the early stages of intestinal amœbiasis in human beings. At the site of these points, necrosis takes place with coincident thrombosis of the blood vessels supplying the affected area; gradually, this process extends, until finally an ulcer results which has a punched-out appearance with its necrotic base lying upon the muscular layers or even upon deeper tissue; the sides and bases of these ulcers consist in many instances of an almost homogeneous material which is partly granular, staining diffusely and devoid of nuclei. In some places remnants of polymorphonuclear leucocytes are seen. The tissue beyond this zone of necrosis is œdematous and densely infiltrated with polymorphonuclear leucocytes; the blood vessels are congested and the muscular fibers are cloudy and swollen. The mucous membrane at a distance from the

ulcers is injected and thickened. Many bacteria can be found in the sloughs adhering to some of the ulcers. Deeper in the tissues, although stained carefully with both intense and delicate stains, no elements can be discovered which from their relation could be supposed to be causative. Indeed, in most cases there are no foreign elements in the deeper parts of the lesions; I have been able to study but few from the mouth and these show nothing more than a circumscribed, superficial necrosis. Many varieties of micro-organisms could be seen in the covering, coagulated material.

ASSOCIATION WITH OTHER DISEASES.

The association of rinderpest with other diseases has proven itself to be, in many places, most important because excessive losses have occurred as a result of the neglect of the danger arising from the complicity of latent blood diseases such as Texas fever and trypanosomiasis. We have had to deal with both of these conditions in the Philippines. Jobling and I [2] have given an account of our experiences with American cattle which were purchased above the Texas-fever belt in the United States, in order not to introduce that disease into these Islands. These animals were given two preliminary prophylactic doses of antirinderpestic serum, which were then followed by an injection of virulent blood twelve days after the second inoculation. At that time we were not aware that Texas fever was endemic in the Islands and so, unwittingly, through the virulent blood infected the American cattle with the latter disease. The result was disastrous, for the combined Texas fever and rinderpest killed some of the animals. Since then we have had several cases in Philippine and Shanghai cattle in which, during an attack of rinderpest, flaring up of a latent Texas fever has occurred. (Chart 12, No. 542.) The combination has resulted in the death of the animals.

We have had no difficulty with trypanosomiasis, chiefly for the reason that we have always been aware of its presence and been prepared for it. For a long time, we have made systematic examinations for the parasite in all animals from which blood was to be taken for inoculation and occasionally we examine every member of the herd. Trypanosomiasis is widespread among the cattle in the Islands, but is most common in the carabaos, which, strangely enough, do not generally suffer any great inconvenience from the infection, provided they are not herded together, have good food, and are kept at work under normal conditions.

Lately, in the Island of Negros, the experience of the veterinary corps with simultaneous inoculation against rinderpest in a district where trypanosomiasis was subsequently found to exist, was most instructive. In 1904 Dr. Jobling had learned that the carabaos may harbor

[2] *Publications, Serum Laboratory, Bureau of Government Laboratories* (1904), 14.

trypanosomata with no bad effects in a large majority of cases, but the problem of the evil effects of the combination of these parasites with rinderpest had never been encountered until toward the end of 1905, when a campaign by the Bureau of Agriculture was instituted to inoculate by the simultaneous method all the cattle on the island mentioned above. At the beginning of this work the results were very satisfactory, but at a later period when the corps had advanced into territory in the north of Negros the death rate rose to an alarming extent and investigation showed the bad results to be due to the inoculation of trypanosomata which were present in the virulent blood. When serum alone was used, or in cases in which there was no reaction to the simultaneous inoculation, the cattle were not affected, but if a reaction occurred the animals died without symptoms of rinderpest, but with enormous numbers of the parasites in the blood.

In Egypt, similar unfortunate results following the simultaneous method of inoculation were observed, but in this case the complicating diseases were Texas and Rhodesian fevers (Arloing).

The most common complicating condition beside these parasitic blood diseases is foot-and-mouth disease, which, although milder in Manila than in the temperate climates, is nevertheless a very serious infection when it occurs in conjunction with rinderpest. Ordinarily, simple foot-and-mouth disease in native or Chinese cattle yields readily to treatment in Manila, but when it appears in conjunction with rinderpest, the combination is almost surely fatal and serum then has no effect upon the course of the malady.

PROPHYLAXIS.

That there are in general but two methods of preventing the entrance and spread of rinderpest, whether in a herd or a country, has now been settled beyond doubt. These methods are those of immunization and of quarantine. Naturally enough, were a perfect quarantine to be established about a herd or about a country where the disease is unknown, then the method of prophylaxis by immunization would be unnecessary. However, unfortunately this is so rarely the case, that resort must be had to the latter means of protection.

Methods of preparing serum.—In order to prepare a serum of high efficiency it is at first necessary to produce in an animal an active immunity against the disease. Various investigators have attempted to accomplish this result by using attenuated virus, but with little success. Heat and cold, light and air, and antiseptics have been tried by Nencki, Semmer, Tokishiga, and others, but, as Koch has said, the susceptibility of the virus does not allow of even gradual attenuation. The result of such chemical and physical methods is therefore to destroy the virus and then all evidence of an immunizing process is wanting.

Gerlach attempted to make use of sheep and goats for reducing the virulence, but these experiments did not result in any true attenuation, for at a later date Koch, and Kolle and Turner showed that in the case of goats the lessening of virulence which might occur was of so incomplete a degree that no practical result was accomplished, while with sheep the virulence was, if anything, increased.

If one can not obtain a naturally salted animal with which to commence operations, it is necessary so to produce the disease in one that it will recover spontaneously and therefore become artificially immune.

Koch, in the course of his investigations in South Africa, discovered that he could accomplish this result by the injection of fresh bile, taken from an animal sick with rinderpest, into a well one. Later, he found that the blood of salted cattle would in some degree protect and that it might be used in combination with virulent blood with good results. Having recourse to these two methods, it was simply necessary to take a salted animal and by the injection of more virulent material gradually produce such a degree of immunity that the serum would be efficient in small doses. Theiler and Pitchford, Danysz and Bordet, Kolle and Turner, Nicolle and Adil-Bey, and others applied these methods with most excellent results. Kolle and Turner used gradually increasing amounts of virulent blood, injected at certain intervals beneath the skin of the cattle. Nicolle and Adil-Bey used the more rapid method of injecting 4 to 8 liters of virulent blood with 25 cubic centimeters of serum.

Still another method, introduced by Yersin, is that of peritoneal lavage, but this has not been extensively employed.

The method in use at the Serum Laboratory of the Bureau of Science.—In our work, the animals to be used for the production of antirinderpestic serum are first inoculated with this serum in amounts varying from 50 to 100 cubic centimeters. After an interval of a day or two, or sometimes perhaps after seven to ten days, they receive from 1 to 10 cubic centimeters of virulent blood; after this injection, others are given two weeks apart and in the following amounts: 50, 100, 250, 500, and 1,000 cubic centimeters. The last injection having been given, three bleedings follow at each of which from 3,000 to 3,500 cubic centimeters of blood are drawn, and when this has been accomplished, 1,500 cubic centimeters of virulent blood are once more injected. Ten days thereafter three additional bleedings are made and again virulent blood is used in a dose of 2,000 cubic centimeters to be followed, as in the other cases, by three bleedings. The same procedure obtains with the subsequent injections of 2,500, 3,000, and 3,500 cubic centimeters of virulent blood. A reaction, to be recognized by a rise in temperature, should result after each injection of virulent blood.

Methods of producing immunity.—Generally speaking, there are three methods of securing an immunity to rinderpest, namely, the active, the passive, and the combined active and passive (Sobernheim). The active immunity is ordinarily of longer duration than the passive and in

animals which have recovered from the natural disease, it is apparently permanent.

The methods in use for producing active immunity are also three in number.

I. *Koch's bile method.*—According to the results of Koch's experiments in South Africa, 10 cubic centimeters of bile taken from an animal on the sixth to the eighth day of the disease will, upon injection into a non-immune one, confer an immunity which will persist for several months. The bile to be used must be clean, greenish and frothy, and must be unmixed with blood; however, in following this method the immunity is not demonstrable until about the tenth day after the inoculation. Rogers, in order to render any bile from a rinderpest animal available, has advocated its filtration, which would remove all organisms contained in the fluid; however, Kolle and Turner have demonstrated that this method could not be satisfactory, because, in order to produce an active immunity, the organisms of rinderpest should be present in the filtrate. The bile method is said to produce an active immunity (Kolle), and it is maintained that the organisms present therein are virulent, but that they are accompanied by substances which hinder their spread in the animal inoculated. The same results can not be obtained with virulent blood and normal bile. Not all investigators have had as favorable results as Koch; those of Lingard and Rogers, for instance, were negative, but this was possibly due to racial differences in the cattle. Inoculation with bile has no value as a curative method.

The advantages of this method are that no reactionary fever, suppression of lactation, or abortions are produced and that the operations can be carried on in the field. The disadvantages are that immunity is not established until the tenth day after inoculation, that the latter is not permanent (four months, Haedicke), that a sufficient quantity of bile may not be obtainable and that it is difficult to preserve, although perhaps the observations of Nicolle and Adil-Bey, that bile desiccated in the presence of sulphuric acid will keep indefinitely, may be confirmed.

II. Hohlstock's modification of Koch's method which consists in giving the bile inoculation a second time and then injecting virulent blood from ten to thirty days thereafter has not found much favor, since Kolle and Turner have shown that there was no appreciable increase in the immunity conferred by this method.

III. Edington's Glycerinated Bile Method, although it has found favor in some places, has been condemned by Kolle and Turner on the ground that the glycerine destroys the virus, and Hutcheon and Rogers state that only a short passive immunity is conferred.

Edington's procedure was to take clean bile after the sixth day of the disease, and dilute it with an equal amount of glycerine; it should then be set aside for eight days. Edington used 15 to 50 cubic centimeters injected into the dewlap, and followed this by a small amount of virulent blood (0.1 to 0.2 cubic centimeter) two days thereafter (ten days later, Nocard and Leclainche). Rogers thought that even foul bile might be used, since glycerine would destroy the organisms present therein.

The advantages claimed for Edington's method were that a long immunity was conferred on all animals which had a reaction and a

temporary one in the case of nearly all the others, and that the bile could be kept for a year (Edington), eighty-five days (Nicolle and Bey), one hundred and sixty-two days (Rogers). The immunity lasts for from two weeks to six months (Jobling).

The disadvantages were that no immunity appeared before the eighteenth day, that many animals did not react and that therefore they would contract the disease from the blood inoculation and die, that two inoculations were needed, and that it was necessary to bleed a sick animal to obtain virulent blood.

COMBINED METHODS OF IMMUNIZATION.

1. *Serum simultaneous method.*—This depends upon the fact that when 1 cubic centimeter of virulent rinderpest blood is inoculated under the skin of one side of the body and a minimal efficient dose of immune serum is injected upon the other, the animal so treated experiences a very mild form of the disease and recovers. (Chart 13, No. 921.) In 90 per cent of the animals a lasting immunity is produced, while upon the 10 per cent in which no reaction occurs, a transient immunity is conferred (Kolle and Turner, Refik-Bey, Nicolle and Adil-Bey).

The advantages of this method are the immediate, permanent immunity produced in the majority of instances, and the transient one in the others, more reactions are produced than with the bile method and only one inoculation is necessary.

The disadvantages are found in the losses by death, which vary from 1 to 4 per cent (among 9,077 cases in Cape Colony there was a mortality of 1.4 per cent), in only temporary immunity in a certain proportion of the animals inoculated, in the interference with lactation and pregnancy, in the difficulty sometimes experienced in obtaining virulent blood,[3] and in the danger of latent blood diseases (Texas fever, trypanosomiasis, foot-and-mouth disease).

This form of inoculation has been variously modified. Nencki and his co-workers, Sieber and Wysnikowitsch, advise giving the serum two hours and Hutcheon administering it forty-eight hours after the virulent blood, and then to watch the temperature and once more to administer serum.

2. *Deferred virulent blood method.*—Another modification and one which is generally used in our work, is to give the serum a day or several days before the virulent blood. (See Chart 14, No. 106.) In using this modification we also follow Roger's suggestion of carefully watching the temperature of the animals, and, if no reaction occurs after the inoculation, a second inoculation with 10 cubic centimeters (2 cubic centimeters for calves) of virulent blood is made. This method requires

[3] To obviate this last difficulty it has been advised to use sheep to propagate the infection, etc.

more labor than the other, but the mortality is less and more reactions are obtained than by any other.[4]

It is necessary to standardize any serum for the race of cattle on which it is to be used for the purposes of inoculation and to this end a number of cattle should be inoculated each with 1 cubic centimeter of virulent blood and with 10, 20, 30, and 40 cubic centimeters of serum. The efficient dose is the one which allows a febrile reaction to take place but after the administration of which the animal shows no other symptom of the disease. In certain cases 20 cubic centimeters will accomplish this result, at least this is as a rule the minimal efficient dose of serum for the race of cattle with which we have to deal in the Philippine Islands; however, even here it will be found that this amount will vary with the racial susceptibility and in a number of instances must be much increased.

Passive immunity by the use of serum.—The method for obtaining passive immunization has been indicated in the section on preparation of serum; its origin lay in the observation that the serum obtained from naturally salted cattle possessed a slight immunizing power and that by the use of large doses, a temporary immunity could be established which would protect otherwise non-immune animals against the natural or inoculated disease.

Several workers, in continuing the study of the natural process, by injecting successively increasing amounts of virulent blood into salted animals, were able to produce a very efficient serum which could be used successfully in doses of 10 to 20 cubic centimeters (Kolle and Turner). Such a serum is also stated to possess curative power.

The immunity resulting by the use of serum alone is transient; according to various observers it varies from several weeks to a number of months, depending upon the quantity employed which has been injected into the animal; 100 to 200 cubic centimeters may produce an immunity which will last through the more extended period.

The advantages of the serum method are that there is no reaction, that no unfortunate results follow in dairy or pregnant cattle, that it

[4] In our work repeated injections of large amounts of antirinderpestic serum in certain races of cattle before active immunization with virulent blood and serum have not given favorable results. These repeated large doses of serum were employed in a number of American cattle in which it was considered advisable to produce a passive immunity at a time when, owing to a long voyage or for other reasons, they were not considered in a sufficiently good general physical condition for active immunization. Many of these animals (which were inoculated with repeated does of serum) and with virulent blood some days after the injection of the first large dose of serum, succumbed to a severe infection of rinderpest or of rinderpest in combination with Texas fever.

Apparently, the repeated doses of serum produced antibodies in the animal body.—P. C. F.

will favorably modify a disease of one to three days' duration, and that the serum probably keeps well for long periods of time.[5]

Dschnuknosky and Kupzis experimented on a process of desiccating serum, which they stated was satisfactory. We followed the method advised by these writers and obtained a product which, while it was apparently useful, was soluble with such difficulty that it was valueless for rapid work in the field. Since the serum if kept in a cool place, retains its activity for a sufficient time, we have adhered to the old method of bottling it in liquid form.

Method of immunizing by defibrinated blood.—In addition to the simultaneous method and its modifications, other systems have been in vogue in certain localities. The best known of these consists in the use of defibrinated, virulent blood, introduced by Danysz and Bordet.

The dosage varies from 50 to 200 cubic centimeters. Immunity is immediate, there is no reaction, and the whole process can be carried out in the field. However, the immunity is but temporary and the material must be perfectly fresh and free from pyroplasmata, trypanosomata, etc. Danysz and Bordet in following this procedure subsequently exposed the animals to infection. Sobernheim maintains that the method is not reliable, but Hutcheon has had success with it; however, Theiler could immunize but 30 to 40 per cent of the exposed animals by this method. A great disadvantage lies in rapid deterioration of the product.

THE COMPARATIVE VALUE OF THE METHODS OF IMMUNIZATION FROM AN EPIDEMIOLOGICAL POINT OF VIEW.

Although rinderpest has great interest as a scientific study, it has in all probability claimed so much attention among investigators because of its economic importance. It is this side which naturally appeals most strongly to the cattle owners, especially in countries or districts where it is difficult to explain just what the meaning of immunization is. It is very difficult for the lay mind and especially for semi-educated people to comprehend that it is not only for the present but also for the future as well that we must work. They insist that we simply tide over existing epidemics, instead of combining such methods of work as will prevent future ones.

The problem resolves itself into the treatment of clean and infected herds in countries where the disease is endemic and in those in which it is merely sporadic and dependent upon introduction from the outside.

In the latter case, even if the serum or bile method alone is used and this means is supplemented by a strict quarantine against outside animals, the spread of the disease can certainly be completely checked.

Greater difficulty undoubtedly arises in countries where the disease is endemic, where new epizoötics are constantly cropping out and where the outbreaks are not apparently due to outside influences. Under such

[5] Theiler and Bitter state the period to be four years.

conditions not only must the disease be checked but active immunity must be conferred on as many of the cattle present in the district as is possible. In order to accomplish this result with a minimal loss of life it is necessary to draw a careful distinction between infected and noninfected animals. In our work, we have divided the cattle with which we have dealt into a "noninfected" and a "contact" class. The latter have been treated with serum, to protect them if noninfected and to favorably influence the course of the disease if they are infected. Later, when it has been possible, these have been given virulent blood in order permanently to protect them. This final inoculation has chiefly depended on the owner's consent. In the case of clean herds, we have thought it wise to use the simultaneous method of Kolle and Turner, giving serum and blood at the same time, or following the serum by the blood, as is done with the animals at the laboratory. Up to the present, the valuable suggestion of Rogers, which involves the regular taking of temperatures of all animals inoculated, has been insisted upon, in order that the records of the animals might be complete and also in order that the reaction necessary in the establishment of immunity should, if present, be noted. In the absence of this reaction we advise a second injection of virulent blood.

During the early days of the rinderpest work in these Islands, much of the work of inoculating was done at the laboratory corral. Persons would bring their animals to this place and leave them until they were ready to be returned. Owing to inexperience a mistake was made at that time in not delaying the inoculation until the animals had been under observation long enough to be sure they were not already infected with rinderpest. During the first eight months, 163 cattle and carabaos were inoculated at the laboratory; 114 received simultaneous inoculation and of these 28 died, a death rate of 32.55 per cent. These results were explained by the fact that most of the cattle sent to the laboratory for treatment had been shipped on infected boats and that probably they were in the incipient stage of the disease when inoculated. Some of the animals also came from districts in Borneo where rinderpest had never been encountered, and these, possibly, were abnormally susceptible to the disease.

During the same time, 28 animals received serum alone and of these four died, a death rate of 14.28 per cent; 11 were given symptomatic treatment only and of these 6 succumbed, a death rate of 54.54 per cent. Such results show that, even in possibly infected animals, serum may be of value, although in this instance the number of infected animals was not known.

There was a mortality of 13.15 per cent from simultaneous inoculation in calves; 15.8 per cent among those to which serum alone was given, and 100 per cent with the individuals which received symptomatic

treatment only. Here again, as in the case of the cattle, the deaths after serum treatment were higher than we might have wished, because some of the animals were in the incubation period of the disease when inoculated, but at the same time, the mortality was not so great as it might have been had serum not been used, which is taken as an evidence of its curative power. This subject will be dealt with below.

During the same period, from January 1 to August 31, 1903, 1,494 animals in the provinces received simultaneous inoculation; 42 of these died, a death rate of 2.8 per cent. Of 776 which were given serum inoculation, 48 died, a death rate of 6.1 per cent. Here again, the curative value of the serum must be taken into consideration in explaining the percentage of loss among animals receiving serum only, for undoubtedly many more were infected with rinderpest than succumbed to the disease.

During the succeeding year the task of inoculating in the provinces was transferred to the veterinary corps of the Board of Health, so that the records of the laboratory cover but part of the period included between September 1, 1903, to August 31, 1904.

These records show that between September 1, 1903, to June 15, 1904, 3,117 provincial inoculations were undertaken by the simultaneous method, with a mortality of 4.09 per cent; 4,464 with serum alone, with a mortality of 0.11 per cent, or a total mortality for both classes of 1.76 per cent.

During the months from April to August, 1903, there were 1,402 animals inoculated with serum or with blood and serum on the Island of Tablas. The records of 1,128 cases are complete and show that of 507 inoculated by the simultaneous method but 6 died, a mortality of 1.18 per cent, and of 621 to which serum alone was given 35 died, or 5.63 per cent. Here again, as in the previous instances, there is some evidence of the curative value of serum.

The results of an attempt to immunize American cattle which were shipped to the Islands for dairy purposes were disastrous, probably because of their extreme susceptibility. (See Chart 15, No. 10, and Chart 16, No. 2.) Upon their arrival in the Philippines all of them received 200 cubic centimeters of a serum, 30 cubic centimeters of which would protect native or Chinese cattle against the inoculated disease. About twelve days later, some of these American animals received the simultaneous inoculation—i. e., 30 cubic centimeters of serum and 1 cubic centimeter of virulent blood. In any case, whether they received virulent blood, or simply serum, all but a few sickened and died of rinderpest and this in spite of early and late subcutaneous and intravenous injections of serum. Indeed, one animal beside the original dose of 200 received 730 cubic centimeters of serum (in all

930) with only this difference, that she lived two days longer than the others.[6]

Undoubtedly, in some cases death was due to a combination of Texas fever and rinderpest, but such instances were few. No difficulty was experienced with the calves belonging to the same herd. To be sure, the dosage of 30 cubic centimeters of serum was used, but they resisted the disease and were later given simultaneous inoculation with good results.

Littlewood, after an interesting experience in Egypt, says it is possible that serum, when injected into imported animals, does not afford the same protection against rinderpest as it does in native herds, more especially if these animals have been exposed to adverse conditions.

I believe that by a judicious use of the serum and simultaneous methods, epidemics may be controlled and the cattle in a district immunized. In the absence of serum, glycerinated bile or defibrinated immune blood may be used as Hutcheon advises. He states that every animal showing a rise of temperature should receive 100 cubic centimeters of serum, a procedure which is practiced in the Philippines. For an animal which has recovered from the natural disease, he advocates the inoculation of 30 cubic centimeters of glycerinated bile, or 300 to 400 cubic centimeters of defibrinated blood. He also advises, as do we, that all infected animals should receive intravenous injections of serum. He argues against the use of fresh bile in infected herds, and believes that this procedure should be applied only in the cases of noninfected animals.

Sobernheim and Haedicke believe that the two most valuable means of combating rinderpest are the bile method of Koch and the simultaneous one of Kolle and Turner. The former is most applicable at the outset of an epidemic, in a country where serum is not available, and the latter should be used extensively in a land where the disease is endemic.

When it is necessary to immunize dairy cattle or pregnant animals the serum method is very valuable for temporary protection. Later, the simultaneous method can be employed. It is also possible, by carefully regulating the dose of serum, to follow it with very small amounts of virulent blood without disturbing the processes of lactation or pregnancy.

Finally, it must be borne in mind that in countries where certain blood diseases are prevalent, it may be dangerous or impracticable to use the simultaneous method.

[6] In all, 56 animals were in the herd which we attempted to immunize; of these 34 were given virulent blood to produce active immunity, and 22 were given serum only, but of the former class, 32 died and of the latter 20. All of the latter contracted rinderpest at about the same time or a few days after the animals which received virulent blood, evidently because the infection spread in the stable. The cattle were received on September 3, 1904, were given 200 cubic centimeters of serum on September 9, and received simultaneous inoculation on September 15.

DIAGNOSIS.

The diagnosis of rinderpest in typical cases presents no difficulty. It may be that in the early stages of an epidemic, the sudden rise of temperature, the serous flow from the eyes and nose, the excoriation caused by the tears, the congestion of the visible mucous membranes, and the severe dysentery may not furnish a sufficiently satisfactory picture upon which to base a diagnosis and that a post-mortem examination will be necessary to decide the matter. The lesions are generally characteristic.

Difficulty arises in those cases in which the temperature reaction is slight and very transient and in which the diarrhœa is late in appearing and is not severe. In such instances an autopsy is necessary.

PROGNOSIS.

The prognosis in uncomplicated cases is bad, in complicated ones even worse. If serum can be used in the early stages of the infection, within twenty-four hours of the first rise of temperature, the chances of recovery are good in all but very susceptible animals. The later in the disease the serum is used, the graver is the prognosis.

TREATMENT.

The serum method is the only one known which is useful in treating rinderpest, but in order that it may have every chance for success, it must be applied before the third day of the disease. The dose should be 100 cubic centimeters injected subcutaneously or intravenously, preferably the latter. The later the stage of the infection, the more necessary it becomes to use the intravenous method. It is possible that several injections may be necessary. (See Chart 17, No. 538, to Chart 18, No. 555.)

Hutcheon says, and we agree with him, that no doubt exists of the strong curative properties of fortified serum when it is used in the early stages of the disease; furthermore, the experience of all workers with serum is that a single large dose is much more effective than a repetition of small or even medium ones and that the intravenous injection in sick animals is more effective than the subcutaneous method.

Dr. Sorrel, formerly of the Serum Laboratory, in his experiments to determine the curative value of our serum, has used as much as 500 cubic centimeters for one animal. In all the cases upon which the serum was tested, the disease had passed its incipiency; the animals had high temperatures, injected conjunctivæ, profuse discharge from the eyes, and in some instances diarrhœa. Sixteen, in all of which the intravenous method of injection was used, were treated, and of this number 3 died. Three animals received 150 cubic centimeters; six were given 200; five, 300; and two, 500 cubic centimeters. Piroplasmata

were found in the blood and organs of all the fatal cases so that it is possible that death was the result of a combination of rinderpest and Texas fever and was not due to the former disease alone. These records seem to show the curative value of serum, even in the advanced stages of the disease; however, all the treatments were by the intravenous method. If the serum is to be used beneath the skin, then the injection must be given as early as possible. Kolle and Turner, Verney, Maberly, and others, have also spoken of the curative value of serum.

A LIST OF THE MOST IMPORTANT ARTICLES ON THE SUBJECT OF RINDERPEST.

Gamgee: *The Cattle Plague* (1866), London.
Dieckerhoff: *Geschichte der Rinderpest* (1890), Berlin.
Kolle and Turner: *Zeitsch. für Hygiene* (1898), XXIX, 309.
Koch: *Reiseberichte* (1898), Berlin.
Kolle: *Ergebnisse d. Allg. Pathologie,* Lubarsch u. Ostertag (1899), VI, 470.
Rogers: *Zeitsch. für Hygiene* (1900), XXXV, 59.
Hutcheon: *Journ. Comp. Path.* (1902), XV, 300.
Dieckerhoff: *Lehrbuch der Specielle Pathologie und Therapie für Tierärzte* (1903), II, Berlin.
Nocard et Leclainche: *Les Maladies microbiennes des Animaux* (1903), Paris, I.
Jobling: *Publications of the Serum Laboratory,* No. IV, *Bureau of Government Laboratories* (1903), Manila.
Plehn: *Der Staatliche Schutz gegen Viehseuchen,* Berlin (1903).
Sobernheim: *Handbuch d. Path. Organismen,* Kolle u. Wassermann (1904), IV, 1246.
Arloing: *Journ. Méd. Vétér. et Zoötech.* (1905), LVII, 321.
Haedicke: *Berl. Tier. Woch.* (1904), L.
Littlewood: *Journ. Comp. Path. and Ther.* (1905), XVIII, 312.

No 905
October , 1905
Weight 550 Age 7 Sex Male Color Inoculation
History Native from Sibuyan

TREATMENT	34	35	36	37	38	39	40	41	42	Date	RESULTS
										11	
										12	
										13	
										14	
										15	
										16	
										17	
										18	
										19	
										20	
										21	
										22	
60 c.c. Virulent Blood "807										23	
										24	
										25	
										26	
										27	
										28	
										29	
										30	
Bled to death										31	
											Typical Rinderpest lesions

CHART NO. 1.

No. 907

October, 1905

Weight 500 Age 7 Sex Male Color Inoculation

History Native from Sibuyan.

17670

TREATMENT	34	35	36	37	38	39	40	41	42	Date.	RESULTS
1 c. c. Virulent blood diluted with 5 volumes saline										11	
										12	
										13	
										14	
										15	
										16	
										17	
										18	
										19	
										20	
										21	
Bled to death										22	Typical lesions of Rinderpest

CHART NO. 2.

No. 908
October, 1905
Weight 500# Age 5 Sex Male Color Inoculation
History Native from Sibuyan.

TREATMENT	34	35	36	37	38	39	40	41	42	Date.	RESULTS.
5 c.c. Virulent blood filtrate										11	
										12	
										13	
										14	
										15	
										16	
										17	
										18	
										19	
										20	
										21	
										22	
60 c.c. Virulent Blood " 907										23	
										24	
										25	
										26	
Died to death										27	Typical lesions of Rinderpest

CHART NO. 3.

No. 904
October, 1905
Weight 500* Age 5 Sex Male Color Inoculation
History Native from Sibuyan

1749

TREATMENT	34	35	36	37	38	39	40	41	42	Date.	RESULTS.
100 c.c. Rinderpest blood "900										10	
										11	
										12	
										13	
										14	
										15	
										16	
Bled to death										17	Typical lesions

CHART NO. 4.

No. 931
December, 1905
Weight 500 Age 4 Sex Male Color Inoculation
History Native from Rabuyanes

1740

TREATMENT	34	35	36	37	38	39	40	41	42	Date.	RESULTS.
5 C.C. Virulent Blood "966										26	
										27	
										28	
										29	
										30	
										31	
										1	
										2	
										3	
										4	Typical lesions of
Bled to death										5	Rinderpest

CHART NO. 5.

No. 938

December, 1905

Weight 250 Age 2 Sex Male Color Inoculation

History Native from Babuyanes.

17470

TREATMENT	34	35	36	37	38	39	40	41	42	Date.	RESULTS.
30 c. c. Filtrate of Virulent blood Chamberland F. #966										26	
										27	
										28	
										29	
										30	
										31	
										1	
										2	
										3	
										4	
Died to death										5	Diarrhoea Typical lesions of
										6	Rinderpest

CHART NO. 6.

No 937
December, 1905
Weight 400 Age 5 Sex Male Color Inoculation
History Native from Babuyanes

TREATMENT	34	35	36	37	38	39	40	41	42	Date	RESULTS
30 c c virulent blood (966)										26	
filtrate "Chamberland F."										27	
										28	
										29	
										30	
										31	
										1	
										2	
										3	
										4	
										5	
										6	
										7	
										8	
										9	
Bled to death										10	Diarrhoea
											Typical lesions of
											Rinderpest

CHART No. 7.

No. 1

January , 1903

Weight 850 Age 8 Sex Male Color Inoculation

History From Borneo (Sarabas)

TREATMENT	34	35	36	37	38	39	40	41	42	Date.	RESULTS.
Virulent Blood 1 c.c. Serum 30.										7	
										8	
										9	
										10	
										11	
										12	
										13	Eyes injected
										14	
										15	Diarrhoea
										16	
200 c.c. Serum.										17	
										18	Died

CHART No. 8.

No 3

January , 1903

Weight 950 Age 8 Sex Male Color Inoculation

History Carabao from Borneo

1740

TREATMENT	34	35	36	37	38	39	40	41	42	Date.	RESULTS.
Blood 1 c. c. Serum 20 c. c.										7	
										8	
										9	
										10	
										11	
										12	Diarrhoea
										13	
										14	Died. Rinderpest.
										15	

CHART NO. 9.

No. 639
August , 1905
Weight 450 Age 4 Sex Male Color Inoculation
History Native of Sibuyan.

TREATMENT	34	35	36	37	38	39	40	41	42	Date.	RESULTS
Natural Infection										6	
										7	
										8	
										9	
										10	
										11	
										12	
										13	
										14	
										15	
										16	
										17	
										18	
										19	
										20	Diarrhoea
										21	
										22	
										23	Died

CHART No. 10.

No. 932
December , 1905
Weight 600 Age 6 Sex Male Color Inoculation
History Native of Babuyanes

17470

TREATMENT	34	35	36	37	38	39	40	41	42	Date.	RESULTS
										31	
										1	
50 c. c. Virulent blood										2	
										3	
										4	
										5	
										6	
										7	
										8	
										9	
										10	Diarrhoea
										11	Bled to death
										12	

CHART NO. 11.

No. 542

July , 1904

Weight 650" Age 7 Sex Female Color Inoculation

History Shanghai

TREATMENT	34	35	36	37	38	39	40	41	42	Date.	RESULTS.
100 c c Serum Subcut.										25	
										26	
200 c c Serum Intraven.										27	
										28	
										29	
										30	
										31	
										1	
										2	
										3	
										4	
										5	Died Texas fever

CHART NO. 12.

No. 321

December, 1905

Weight 1100 Age 5 Sex Male Color Inoculation 100 c c Serum Dec 2

History Australian steer

TREATMENT	34	35	36	37	38	39	40	41	42	Date.	RESULTS
										17	
										18	
										19	
35 c c Serum 1 c c Virulent blood										20	
										21	
										22	
										23	
										24	
										25	
										26	
										27	
										28	
										29	
										30	
										31	
										1	
										2	
										3	
										4	
										5	
										6	
										7	Returned to owner
										8	

CHART No. 13.

No. 106
December , 1905
Weight 75 Age 4 mos Sex Male Color Inoculation
History Australian Calf

TREATMENT	34	35	36	37	38	39	40	41	42	Date.	RESULTS
50 c.c Serum										23	
										24	
										25	
										26	
										27	
										28	
20 c.c. Serum 1 c.c. Virulent										29	
										30	
										31	
										1	
										2	
										3	
										4	
										5	
										6	
										7	
100 c.c. Serum										8	
										9	
										10	
										11	
										12	
										13	Returned to owner
										14	
										15	

CHART NO. 14.

No. 10
September , 1904,
Weight _____ Age _____ Sex _____ Color _____ Inoculation _____
History American Cow

TREATMENT	34	35	36	37	38	39	40	41	42	Date.	RESULTS.
										3	
										4	
										5	
										6	
										7	
										8	
200 c. c. Serum										9	
										10	
										11	
										12	
										13	
										14	
1 c. c. Virulent blood 30 c. c. Serum										15	
										16	
										17	
										18	
										19	Eyes injected
										20	
										21	
										22	
150 c. c. Serum										23	Diarrhoea.
100 c. c. Serum intravenous										24	
										25	Died
										26	

CHART NO. 15.

No. 2
September, 1904
Weight _____ Age _____ Sex _____ Color _____ Inoculation _____
History American Cow

TREATMENT	34	35	36	37	38	39	40	41	42	Date.	RESULTS.
										4	
										5	
										6	
										7	
										8	
200 c. c. Serum										9	
										10	
										11	
										12	
										13	
										14	
Virulent Blood 1 c. c. Serum 30 c. c.										15	
										16	
										17	
										18	
										19	
										20	
										21	
										22	
										23	
										24	
										25	
										26	
										27	
										28	
200 c. c. Serum Intraven.										29	Eyes injected
200 c. c. Serum.										30	
										1	
100 c. c. Serum.										2	Diarrhoea
200 c. c. Serum.										3	
										4	Died
										5	

CHART No. 16.

No. 538

July , 1904

Weight 500 Age 4 Sex Female Color Inoculation

History from Shanghai

17470

TREATMENT	34	35	36	37	38	39	40	41	42	Date.	RESULTS.
50 c.c. Serum Subcut.										25	
										26	
										27	
										28	
										29	
										30	
										31	
										1	
										2	
										3	
										4	
										5	
										6	
										7	
											Well.

CHART NO. 17.

No. 555

July , 1904

Weight 850 " Age 9 Sex Male Color Inoculation

History from Shanghai

TREATMENT	34	35	36	37	38	39	40	41	42	Date.	RESULTS.
50 c.c. Serum Subcut										25	
										26	
										27	
										28	
150 c.c. Serum Intraven										29	
										30	
										31	
										1	
										2	
										3	
										4	
											Well

CHART NO. 18.

PRELIMINARY GEOLOGICAL RECONNAISSANCE OF THE LOBOO MOUNTAINS, BATANGAS PROVINCE.

By W. D. Smith.

(*From the Division of Mines, Bureau of Science, Manila, P. I.*)

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Description of species.
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INTRODUCTION.

The writer, during portions of the months of August and September, 1905, was detailed from the Mining Bureau to make a preliminary geological inspection of the Loboo region where some prospecting was being carried on. Unfortunately, this reconnaissance was of necessity limited, but it is thought even the incomplete data already at hand should be made available. Furthermore, as very little literature and that not easily accessible to the public, can be found treating of this portion of Batangas Province, these notes may possess some utility at home, as well as scientific interest abroad.

The able Spanish engineer, Centeno,[1] has written of the Taal tuff deposits, which extend partly into the district discussed in this paper, but he extended his observations to a region no farther east than the pueblo of Batangas. Von Drasche[2] published some notes on the region of southeastern Luzon, but he likewise did not touch upon the Loboo country.

The field work done by the writer consisted primarily of an inspection

[1] J. Centeno: *Estudio geologico del Volcan Taal*, Madrid, Tello (1885).

[2] R. v. Drasche: *Fragmente zu einer Geologie der Insel Luzon*, etc., Vienna, Gerold's Sohn (1878).

of certain prospect work carried on by some prospectors from Batangas on a group of twenty-one claims in the Loboo Mountains, and trips east and west to the coast from these workings.

The site of these claims is indicated by crossed hammers on the general map (Pl. I), which has been adapted from d'Almonte. They are situated on the headwaters of the Calbasahan River in the pueblo of San Pedro, some 40 miles more or less from Batangas, and about 6 from San Juan de Bocboc.

The writer wishes to acknowledge the many courtesies and valuable assistance rendered by Messrs. Harris, Weeden, Weber, and others of this camp. Particular mention is due to Mr. Weber for the fossils shown on Plate IV, and for several compass route surveys which may be of considerable value in the future.

DISCUSSION.

Physiography.—The topography of this region is typical of mountainous country in the Philippines. The Loboo Mountains rise rather abruptly from a plain, with the steeper and shorter slopes to the east and south. Save for a considerable break where the Loboo River cuts through to the south, they extend as a chain continuously and approximately parallel with the coast. To judge from the trend of the range and this break, one might infer a fault with considerable horizontal displacement. However, no further indications of the latter have been seen. The mountains themselves exhibit nothing which materially differs from the usual erosion features of mountains in general; that is to say, they are not of the faulted block type, Karpathian or Jura, etc., although they approach more nearly the last. They attained their bulk and elevation from their particular mode of structure, which was that of a great anticline of stratified rocks pushed up from below, when the old, igneous stump slowly rose; following upon this rise there ensued the *growth* of the mountain topography by which they attained to their present accentuated relief.

The softer sedimentaries would produce rounded forms, while the more resistent igneous core would form the backbone of the range and stand up in peaks and sharp ridges.

Physiographically, the plain country possesses a particular interest. It is a plain of deposition, made up of heterogeneous materials, has a fairly even sky line and is being dissected by streams which run in deep gorges. As the writer went overland from Calamba, through Lipa to Batangas, he had a good opportunity to study the materials of this plain which on examination were seen to have been deposited in part from volcanic showers and in part by streams.

The country just east of Batangas, toward the Loboo Mountains, is an extension of the Taal tuff area. Its average elevation in the vicinity of the latter range is about 1,000 feet, but this increases gradually to

the north so that in the vicinity of Lipa it is between 1,500 and 2,000 feet. When one rides over this plain in any direction from the military road, he finds it to differ widely from the suggestion of apparent evenness obtained by a view from the highway. This old ash and tuff plain is at many points broken by deep gorges which may be 100 to 150 feet in depth, with almost vertical walls, veritable gashes across the landscape. Everywhere, signs of a very youthful stage of topography and of recent and rapid elevation of the plain are evident.

To the northward and westward of the Loboo region, lie the active and extinct volcanoes of Taal, Maquiling, Malarayat, and San Cristobal. These exhibit still another type of topography, which, however, lies outside the scope of this article.

In this region, then, we have three distinct types:

(1) That of the Loboo—that is, mountains which are not volcanic.

(2) The plain.

(3) The volcanic.

Drainage.—The entire district is well watered, particularly so during the time of the writer's visit, which was in August and September. The records of the Antimonan meteorological station, which is the nearest thereto, show a total rainfall from July, 1904, to July, 1905, of 95.25 inches, the three months of greatest precipitation being September, October, and November. As there is no station at Batangas, data could not be obtained from that side of the range, but it is not probable that the Loboo Mountains afford a barrier which is sufficiently high and continuous to make the record materially different.

TABLE I.—*Meteorological data for Antimonan station, July, 1904, to July, 1905.*

Month.	Mean temperature.	Average rainfall.
	°C.	mm.
July	28.0	54.8
August	28.0	141.7
September	26.8	423.9
October	27.0	556.2
November	26.0	536.2
December	25.5	166.3
January	25.5	73.5
February	25.6	35.0
March	27.2	10.4
April	27.2	231.2
May	28.8	77.6
June	28.0	112.4
Total		2,419.5

The four principal streams of the region are the Calumpan, flowing into Batangas Gulf at Batangas; the Loboo, Rosario, or Pinacanauan, as it is variously called, debouching into the sea to the south near the pueblo of Loboo; the Lanay, or San Juan, emptying to the east near

San Juan de Bocboc; and the Calbasahan, the smallest of the four, heading in the vicinity of the district where the present prospecting is being carried on and flowing due east to the sea near Guinasepa. Although the actual flow of water has not been measured on the Calbasahan, it seems fairly certain that at all times of the year there will be a sufficiency to supply all of the ordinary mining needs, should such arise.

Good harbors are to be found near Batangas, in Batangas Gulf, and at Layan. The one at San Juan is inferior, because of its exposure in the time of the northeast monsoon. All this coast has been charted and can be more critically studied from the Coast and Geodetic chart, No. 4714.

Vegetation.—The Loboo Mountains are heavily clothed on both their east and west slopes with a forest growth, some of the trees being red and yellow narra (*Pterocarpus*), balete (*Ficus*), and the anahao palm (*Livistona*); these are all of goodly proportions and quite abundant, so that it will be easy to procure timber.

Large areas, on which the grasses talâhib (*Saccharum spontaneum*) and cogon (*Imperata exaltata*) run riot, are on the plains at the foot of the mountains; occasional sampaloc (*Tamarindus*) and antipolo (*Artocarpus*) trees are also seen.

General and local geology.—A summary of the general geology is as follows; it is shown in the ideal section on Plate II:

PROVISIONAL, TABULAR STATEMENT OF STRATIGRAPHY.

RECENT: Tuff and alluvial deposits.

PLEISTOCENE: Tuff deposits containing fragments of mammalian teeth.

PLIOCENE: Limestone fossils with Bornean affinities.

MIOCENE: Sandstone.

MIOCENE: Shaly sandstone containing *Vicarya callosa.*

UNCONFORMITY: Basal conglomerate.

PRE-MIOCENE: (Igneous) Diorite with quartz fissure-veins, cupriferous and auriferous.

The basement rock of the region is one to which the field name of diorite has been given—i. e., it has a granitic texture and contains plagioclase-feldspar and hornblende as primary minerals. In some places it was seen to verge upon a granite, in others it kept its strictly dioritic composition but became very decidedly gneissic. The rock as a whole is decidedly coarse grained.

It is in fissure veins which cut this rock, that the minerals of economic interest are found. As the diorite in this region is all more or less altered and stained with either iron or copper oxides and carbonates, considerable difficulty was experienced in obtaining a good sample from which to make a petrographic examination.

The diorite.—No. 1: Section of gneissic phase of diorite from one-half mile below Camp Cronk, pueblo of San Pedro, Loboo Mountains.

Megascopic.—In the hand specimen, the rock is distinctly banded, the white bands consisting of plagioclase-feldspar; the dark ones of amphibole. It has a decided granitic texture. Striations on the plagioclases are easily seen. The average amphibole crystal measures from 2 to 4 millimeters in length.

The rock breaks with a rough fracture, but parts easily although somewhat unevenly, along the zone of the amphiboles.

Microscopic.—The rock, when examined in thin section, shows idiomorphic crystals of plagioclase by Michel-Levy's method of symmetrical extinction, determined mainly as labradorite, and actinolite (the grass green amphibole). The labradorite belongs to that portion of the series of plagioclase-feldspars which is characterized by the predominance of lime, and would be expressed by the formula Ab_2An_3.

It is very plainly seen in a number of places in the slide that there has been secondary granulation and cementation. This minute quartz filling is undoubtedly a part of the general and larger quartz cementation indicated more plainly in the quartz fissure veins of the region.

Although the nature of our work does not, at present, permit of petrographic study in great detail, a very rough attempt was made to classify this rock according to the quantitative classification given by Cross, Iddings, Pirsson, and Washington.[3] By this method, the proportion of salic to ferric minerals was found to be 84.32 to 15.70 per cent, and from further inspection of the mineral constituents, the writer has provisionally placed it in the subrang hessase of the Dosalane class, but measurements on several more slides and a chemical analysis would be necessary to make this classification entirely trustworthy. For the present and for the purposes of this paper the term diorite is sufficient.

The sedimentaries.—Above the igneous basement and best seen in canyons near the mountains, is a basal conglomerate of varying thickness with, in places, a shaly matrix, in others, coarse sandstone around pebbles and even large bowlders of dioritic rock. Because of limited sections, a thickness of more than 50 feet was nowhere to be seen, but if the observations of the writer in other parts of Luzon can be taken as a guide, it undoubtedly greatly exceeds this figure. This conglomerate we believe to be equivalent to that of the Agno and Bued river beds of Benguet, in those places in which the writer has studied it with A. J. Eveland, geologist, who has been working in that district.

A dark, coarse, sandy shale containing a suite of fossils having a decided Miocene aspect lies above the basal conglomerate. One of the latter is, in fact, *Vicarya callosa,* which, it may be said, represents one of the milestones of Philippine paleontology. This one characteristic form, together with the accompanying fossils, makes it almost certain that all the sedimentaries lying stratigraphically above it are at least younger than the Eocene. These questions will be considered more at length in the discussion of the paleontology which is to follow.

As erosion to a great extent has removed these beds and as the excessive formation of talus due to weathering has concealed a great part

[3] *Quantitative Classification of Igneous Rocks.* University Press, Chicago, 1903.

of those which remained, an estimate of the thicknesses of these formations without more detailed study is an extremely difficult one. This shale may have had any thickness between 100 and 1,000 feet. Minute lenticular seams of lignite and pieces of resin are occasionally seen therein.

A limestone, also of unknown thickness, lies above this sandy shale, and again, over the latter, a sandstone, but owing to limited time, no close investigation of the formations lying much above the shale horizon was made.

The fossils shown by Plate III were collected by the writer from the shale in the Loboo River; those on Plate IV by Mr. Weber, of Batangas, from the limestone, just above the latter, on the same stream. This limestone is of a dirty, cream color; it resembles some horizons in Cebú and occurs in rather thin, fissile beds.

A great thickness of most interesting deposits rests unconformably above these typically marine sediments. These, in all probability, are of volcanico-marine origin. The rock in this region is called dhobie by the American prospector, probably because he confuses it with the adobe from the western part of the United States, with which, however, it must not be confounded. The latter is generally an alluvial deposit derived from weathered basic igneous rocks, whereas the former for the most part is a tuff of volcanic origin, which has been blown out and deposited either in the sea or lagoons. Stratification is very pronounced in this Batangas deposit, which is not the case with the adobe of the Western States of America. However, the chief difference is to be found in the heterogeneous physical and mineralogical aspect of the former, yet the writer does not assert that there is no true adobe in this district; in fact, in the northern part, in the neighborhood of Mount Maquiling it occurs typically.

These tuff deposits exhibit very different facies throughout their great extent. In some localities they show a distinct stratification, while distant only a few feet, no sign of this can be seen. One stratum may be composed of extremely fine silt, with the layers above and below distinctly constituting a tuff which contains both fine and coarse materials. Fragments of pumice, obsidian, and round concretions of fine clay (lapilli) all may be encountered in one exposure.

A series of eight samples collected from an exposure near the city of Batangas by Mr. George Weeden, of that city, shows the variations in these deposits exceptionally well. All of these samples occurred in layers varying from 6 inches to several feet in thickness and cliffs of from 50 to 100 feet in height, and entirely composed of No. 7, have been seen.

The following is a brief summary of the lithological characters of the several beds, given in order from above downward:

No. 1: Fine grained, almost a mud, but slightly vesicular, and possessing distinct stratification. Color, gray. Dark specks, which are minute fragments of volcanic glass, are occasionally seen. It parts readily along the bedding plane.

No. 2: Differs very little from the preceding, perhaps a little finer grained.

No. 3: Much coarser than No. 2, made up of black and yellow angular fragments. Its matrix about the same as the body of No. 2. The black fragments, on being broken open, are seen to be dull in color, exceedingly fine grained, not glassy, but felsitic, also slightly vesicular. Occasionally an incipient sanidine crystal can be seen.

No. 4: Very coarse, but with practically the same composition as No. 3. Very loose and easily falling to pieces. Scoriaceous fragments more abundant.

No. 5: Dirty yellow in color, more coherent; concretions of fine yellow silty material occasionally seen. It contains fossil teeth, probably of *Bovidæ*.

No. 6: Practically the same as No. 3.

No. 7: Concretionary structure *very* pronounced. These concretions are usually almost perfectly round and vary from only a few millimeters to 10 or 20 centimeters in diameter. Concretions composed of the same material as the matrix.

No. 8: Appears altogether to lack the concretionary structure, at least this is so in the hand specimen; otherwise it differs in none of its essentials from No. 7. A slight efflorescence of a material which doubtless is sodium carbonate has appeared since the sample was received at the Bureau.

This admirable series shows the difference in the conditions which prevailed, but at present we are unable to give any reliable data as to the rapidity of change. Considerations of this kind, together with questions as to the origin of the series, etc., will, it is contemplated, be taken up by another member of this Bureau in connection with his work on Taal Volcano, with which these deposits are closely related.

This being the case, it is in this connection sufficient to state that the tuff-covered area as shown by Centeno on his map of the year 1885, extends beyond the limits given by the latter to the Loboo Mountain area and even to the eastern slopes of the range.

This deposit, or series of deposits, is in some places very recent, as is shown by the fossil rice blades, identical with those growing in the fields to-day, which occur in it, so that at least one mighty cataclysm probably took place within the historic period and at a time when this country had partly risen from the sea.

Reference to Plate II will suggest something of the field relations of the tuff obtaining in this region.

ECONOMIC GEOLOGY.

Considering the stage of the prospecting which is being carried on in this district, it might be premature to speak of the mineral veins as ore deposits. The country might be fairly well mineralized, without the occurrence of any workable body of ore.

For the most part, the metallic minerals are confined to veins of the fissure type, but some indications of lateral secretion in the country rock itself are present. Two sets of veins appear to be more prominent than the rest, the main one of these strikes in the direction of N. 70° W. whereas the other trends N. 45° to 57° W. By comparing the former direction with the general trend of the Loboo Range (see map, Pl. II) it is seen that the two agree very closely.

The gangue material of these veins varies, being for the most part quartz and a rock which owing to its altered condition has so far eluded any satisfactory classification. This second vein-stuff is greenish in color with brown specks of about one-third of a millimeter in diameter throughout the gangue. The writer is of the opinion that this rock is porphyritic, the phenocrysts having decomposed to give the rusty-brown specks. We were unable to work out the relation of this second type to the quartz veins at the time of our visit to the district. Whether or not they branch off from the former is not as yet determined, so that this highly important point is left for future solution. The widest quartz vein which was seen, measured from 4 to 6 feet where it was opened up on the "Maze" claim; however, the average thickness of these veins as seen in the present workings and outcroppings is not over 1 foot.

About one mile down the Calbasahan River from Camp Cronk and up a small tributary of the latter, termed Arizona Creek, a ledge was encountered which in places more nearly resembled a pegmatite than anything else, although on its borders it graded into the country rock, becoming coarser grained and more abundant in the ferromagnesian minerals laterally. This ledge measured 40 feet in width. The surrounding rock is decidedly gneissic. It is approximately vertical and strikes N. 70° W. A sample taken from a cutting across the whole face on assay showed only a trace of gold and 0.04 per cent of copper.

Many of the veins in this district are vertical, but a number which have a varying dip of from 30° to 89° exist and in this locality this dip almost invariably is to the west.

The following is a list of the minerals of economic value occurring in these veins:

1. Azurite.
2. Bornite.
3. Chalcocite.
4. Calcopyrite.
5. Cuprite.
6. Malachite.
7. Melaconite.
8. Gold.
9. Molybdenite.
10. Proustite.?
11. Silver.

The black oxide of copper seems to be the chief mineral of economic value, although bornite in some places holds out good prospects. One streak about two inches wide was exposed in a tunnel in the "Reina Victoria" claim of Mr. Montague, which gave the highest values found in this district. As this streak has every appearance of widening out into a healthy vein, further development at that place might not be amiss.

As a rule the minerals occur in little patches and pockets throughout the localities visited by the writer.

Molybdenite was found to a certain extent associated with copper minerals, but confined more closely to the gneissic zone. It was nowhere seen in workable quantities. However, its discovery is very interesting as it is believed this is the first authentic report of molybdenite from the Philippine Islands.

Assays.—Previous to the writer's visit a small number of samples had been sent to this Bureau for analysis. They gave exceedingly favorable results, and upon this basis a provisional estimate of the probable cost of mining and treatment of these ores was made for the prospectors in that district. However, this estimate was held over until further sampling had been done and some study of the region completed. The writer regrets that the results of the assays and of the personal examination of the district do not induce us to place any great confidence in the earlier sampling and reports from the camp in that region. However, negative determinations are often as valuable from a commercial standpoint as are positive ones and therefore we shall here give the results of both samplings to show what erroneous ideas may be deduced concerning a district even when it is the effort of the interested parties to be perfectly honest, for the latter often mislead themselves as badly as they do those who are on the outside.

Two tables (Nos. II and III), giving results of analyses follow, the former of ores collected by prospectors and forwarded to this Bureau, the latter of samples taken by the writer and assayed by the same assayer.[4]

Table II.

Number.	Gold.	Silver.	Copper.
			Per cent.
1	Color.	Trace.	7.67
2	0.4 oz. / $8.27		10.56
3	Color.	Trace.	.4
4			17

Table III.

Number.	Gold, oz.	Gold, value.	Copper.
			Per cent.
1	Trace.		0.08
2	0.05	$1.03	1.24
3	.18	3.72	2.21
4	Trace.		.07
5	.02	.41	.22
6	.06	1.24	26.21
7	Trace.		.61
8	Trace.		.40
9	Trace.		.03
10	Trace.		1.15
11	Trace.		.04
12	Trace.		.14

[4] All assays are by Paul J. Fox, of this Bureau, to whom the thanks of the writer are due.

These samples were all taken according to the most approved methods adopted by mining engineers and the strictest impartiality and caution were observed.

From a limited examination, the best prospects at present are seen to be the vein outcropping at the point from which sample No. 3, Table III, was taken and the thin but rich streak where No. 6, Table III, was secured. Both of these are, in the opinion of the writer, well worth further development work. The ledge which yielded No. 3, from its peculiar character, trace of values and width, might well be given attention.

The gold ore is in part free milling, as some of it was crushed and panned, but for the greater part, it is believed, it will prove to be refractory.

Claims and titles.—In this district there are twenty-one claims staked out at the present time, although, to the writer's knowledge, no patents have been issued. Because nothing beyond prospecting and assessment work is being carried on in this place, an existing plat of the claims is not published at this time; the latter shows the courses of the various veins, but owing to the exceedingly crude and in some cases inaccurate compass surveys it would only be misleading.

This portion of the discussion will be concluded with the statement that the work so far done on the mineral resources of the Loboo region is too meager to allow us either to condemn it or to be carried away with an exaggerated enthusiasm. The region, we firmly believe, merits further exploration, but beyond that we do not presume to advise.[5]

PALEONTOLOGY.

INTRODUCTION.

Although only a small number of fossils are to be described in this paper, nevertheless this is the first instance in which they have been encountered in this district. They have, of themselves, a peculiar interest and also a bearing on certain economic questions, and finally, their affinities with forms from neighboring parts of the Malay region warrant their full discussion.

To the writer's knowledge, no fossils have been figured or described from this portion of Luzon. A knowledge of them is absolutely essential for the complete and proper understanding of the relations of the stratified deposits and of the latter to the igneous rocks. At present, any economically valuable mineral deposits which may occur are likely in the first instance to come from the igneous basement, but occurrences, small to be sure, of lead and gypsum in the sedimentary formations appear to promise future values from these higher horizons and in the

[5] Since writing the above, specimens of very good looking copper ore (chalcocite), galena, and stibnite have been brought in from the Loboo Mountains near Batangas city. The country is, to say the least, well mineralized.

delimitations of the latter, fossils play their most important part. Furthermore, in this district as well as farther north in Luzon, some small amount of prospecting has been done for coal and upon this subject some deductions resulting from the study of the fossils of the several districts and which may be found to possess practical value, can be made. Concrete examples are always more convincing than abstract statement. One may be given as follows: In all the coal fields visited by the writer in Batan and Cebu islands, the coal seams have been found to lie stratigraphically *below* the Upper Miocene beds. Now, in the Batangas district, as well as farther north in several localities, we have found beds with an Upper Miocene fauna resting just *above* the igneous base. This means that the Lower Miocene, Oligocene, and Eocene are missing and from this, in turn, the conclusion must be reached that coal beds corresponding to those of Batan, Polillo, and Cebu are wanting in many of these localities. Great care should be taken in interpreting this statement, which does not mean that coal will not be found in northern Luzon, for it is known to occur in the Zambales Range and in the Cagayan Valley. On Plate III the most typical of these Upper Miocene fossils are figured and these may be used as indicators.

Description of Species.

ZOÖPHYTA.

Fungidæ.

CYCLOSERIS M. E. & J. H.

Cycloseris hidalgi sp. nov. Pl. IV, fig. 1.

C. f. *C. decipiens* Mart., Tertiärschicht. auf Java. *Pl. XXV, fig. 3, p. 143.*

Thickness, 5 millimeters; diameter, 58 millimeters. Circular, with radiating septa arranged in cycles, I–VI. Number of principal septa, 48.

Thin, upper surface convex, slightly depressed in the center.

Locality: Limestone on Loboo River, Batangas Province.

Age: Younger Miocene.

Eupsammidæ.

BALANOPHYLLIA.

Fig. 2 (Pl. IV) is a photograph of a very poor specimen, from the same bed as that in which *Cycloseris* was found, which I have provisionally called a *Balanophyllia.*

FORAMINIFERA.

ORBITOIDES d'Orb.

Description of genus.—Test discoidal, with circular or stellate contour, often bent, exterior smooth or with radial striæ, and composed of numerous concentric annuli disposed about a primordial spiral of three to five whorls. The rings are divided by transverse partitions into small, rectangular chambers and the septa and marginal cord are traversed by canals. Superimposed over the median series of the principal chambers on both sides are several layers of flattened secondary chamberlets, which are likewise disposed in concentric rings. (Zittel.)

Orbitoides martini sp. nov. Pl. IV, figs. 6, 7, and 9.

Specimen with edges somewhat broken, Disc-shaped, with slight protuberance in the center; often found bent and warped, rarely perfect. Surface perfectly smooth. Section (fig. 9) shows no central chambers larger than usual, as is the case in some species of orbitoides. Chambers in the median line lozenge-shaped and with their long axes at right angles to those of the chambers in the outer cycles. Diameter of individuals varies from 15 to 50 millimeters.

Locality: Limestone on Loboo River, Batangas Province.

Age: Younger Miocene.

Similar forms are plentiful in the limestones of Cebu, above the Coal Measures.

GASTEROPODA.

TURBO Linn.

Turbo borneënsis Bttg. Pl. IV, figs. 3 and 4.

Turbo borneënsis Böttger., Die Eocänformation von Borneo. *Pl. I, figs. 3 and 4, p. 11.*

These are casts of individuals which are almost identical with those figured by Böttger, though they are a trifle smaller. Height, 15 millimeters; diameter of bottom whorl, 25 millimeters. These casts are very abundant both in Batangas Province and in Cebu.

Locality: Limestone on Loboo River, Batangas Province.

Age: Younger Miocene in the Philippines, though it is found in the Eocene in Borneo.

Fig. 11, Plate IV, is probably a young specimen of this same species.

NERITA Linn.

Nerita punctata sp. nov. Pl. IV, fig. 8.

Thick ovoid, or semiglobose, imperforate. Surface marked by rows of small nodes which are arranged perpendicular to the lines of growth. The figure on Plate IV shows this specimen at natural size.

Locality: Limestone on Loboo River, Batangas Province.

Age: Younger Miocene.

DRILLIA Gray.

Drillia (?) (Pleurotoma) weberi sp. nov. Pl. IV, fig. 10.

Imperfect specimen which has been provisionally classified as *Drillia* from a comparison with *Drillia allioni* Bell, from the Miocene of Baden, Austria. As very few of the generic, to say nothing of specific, characters can be made out on our specimen, this must remain with an interrogation attached to it.

CYPRÆA Linn.

Cypraea paniculus? Bttg. (young form).

Cypraea paniculus Böttger. Die Eocänformation von Borneo. *Pl. III, fig. 23, p. 22.*

Fig. 12 shows the size of this specimen, which is probably the young of *paniculus*.

Locality: Limestone on Loboo River, Batangas Province.

Age: Younger Miocene.

VICARYA d'Arch.

Vicarya callosa Jenk. var. **semperi.**

Vicarya (?) *callosa* Jenk. Quart. Jr. Geol. Soc., Vol. XX, *Pl. VII, fig. 5, p. 57.*

Vicarya callosa Jenk. Tertiärschichten auf Java, Martin. *Pl. XI, fig. 3, p. 62.*

Vicarya callosa Jenk. Sammlungen des Geologischen Reichsmuseums in Leiden, Vol. V, 1896, pp. 53, 69.

Also noted in Japan and India, but we are unable to give citations of the literature.

Fig. I, Plate III, is a photograph (slightly enlarged) of a rather imperfect specimen, but which still shows enough of the sculpturing to enable us easily to identify it as belonging to this species. As the shaly sandstone from which it was taken was exceedingly hard, the specimen suffered unavoidable mutilation.

This Batangas fossil is somewhat larger than those figured by Martin from Minanga and Dicamui brook in Luzon, but is about of the size of a specimen which the writer examined in the museum of the Imperial University at Tokyo, Japan. It is also of nearly the same dimensions as that described by Martin from Java.

The characteristic features of all these specimens are the flattened whorls, the row of strong spines which are found next to the sutures, the sigmoidal growth lines which have their deepest incurvation between the rows of spines.

The Batangas specimen possesses at least 10 whorls, its length is 88 millimeters, width 3.5 millimeters, and the angle of spire is 27°.

Locality: Loboo River, Batangas Province.

Age: Upper Miocene.

STROMBUS Linn.

Strombus javanus Martin, var. nov. **semperi.** Pl. III, fig. 3.

Strombus javanus Martin. Tertiärschicht. auf Java. *Pl. IX, fig. 2, p. 47.*

As this is a cast a very close comparison with Martin's figure can not be made, and it is probable that, were the outer shell present, this would be found to be not even a variety. At present the only difference is in the shape of the whorls, those of the Batangas specimen being more rounded. The fluting on the margin of the expanded lip can be seen very plainly. Height, 30 millimeters; width of bottom whorl, including expansion of lip, 19 millimeters.

Locality: Loboo River, Batangas Province, in shaly sandstone just above igneous basement.

Age: Upper Miocene.

Fig. 13 is a cast undetermined, but which is found in great numbers in the same beds with *Vicarya callosa.*

TAPES Megerle.

Tapes (?) **lobooënsis** sp. nov. Pl. III, fig. 2.

This cast has the *Tapes* outline and area of *Tapes.* Length, 30 millimeters; height, 18 millimeters.

So far as we know, this is the first instance of the finding of this genus in the Philippines, and therefore we assign to it the specific name given above, although we recognize its poor claims to the rank of a type.

Locality: Shaly sandstone beds of Loboo River, Batangas Province.

Age: Upper Miocene.

Tapes sp. indet. *Pl. III, fig. 7.*

Another poor cast of a fairly common form in same bed with *T. lobooënsis.*

PTEROPSIS Cour.

Pteropsis (?) **bullata** sp. nov. Pl. 3, fig. 5.

This is a fairly perfect cast of a very globular species of what we take to be *Pteropsis.* The heavy growth lines appear to be very characteristic and in this species each ridge is made up of two and sometimes three minor ridges. The

right valve is slightly larger than the left. Length, 25 millimeters; height, 21 millimeters.

Locality: Shaly sandstone beds of the Loboo River, Batangas Province.

Age: Upper Miocene.

MACOMA Leach.

Macoma rosariana sp. nov. Pl. III, fig. 4.

The cast of a very triangular form with a rapidly descending anterior margin, marked by a prominent sinus parallel to this edge.

The figure does not at all bring out the sculpture, but there is enough on the cast to enable any one examining it to make out the rather prominent growth lines to be seen as small ridges from 2 to 3 millimeters apart. Length of shell, 43 millimeters; height, 34 millimeters.

This form is not greatly unlike *M. nasuta* Carp. from the Upper San Pedro series (Pleistocene), Los Cerritos, California.

It is quite difficult in these casts to distinguish between *Tellina* and *Macoma*. In this case, the writer has considered the more triangular and blunter shape and the rougher surface as indicating the latter rather than the former.

Locality: Shaly sandstone beds of the Loboo River, Batangas Province.

Age: Upper Miocene.

ARCA Lam.

Arca nodosa Mart. var. nov. **batanensis.** Pl. III, fig. 6.

Shell trapezoid, equivalve, with a wide amphiditic area, distant conspicuous beaks, and radial sculpture, a wide byssal gape, a long, straight, transversely dentate hinge line, with many similar teeth. (Zittel.) This shell, which is the commonest form in the Tertiary as well as the Recent deposits of these Islands, is quite similar to Martin's *A. nodosa*, however with the nodes not so prominent. It measures 20 millimeters in length, 11 millimeters in height, and the number of ribs is 22. The nodes are found only on the lateral ribs.

Locality: Shaly sandstone beds on Loboo River, Batangas Province.

Age: Upper Miocene.

The variety name of *batanensis* has been given because of the great abundance of this form in the beds above the Coal Measures on Batan Island, P. I.

The writer has not as yet seen any living form which is quite like this. The living species are all much larger. The *Arcidæ* are still the most abundant of our Philippine marine mollusca.

LUCINA Brug.

Lucina sp. indet. Pl. III, fig. 8.

A cast of a species, as yet undetermined, with very prominent beaks. A portion of the shell, still remaining, possesses a very fine sculpturing consisting of parallel growth lines.

Locality: Shaly sandstone beds on Loboo River, Batangas Province.

Age: Upper Miocene.

SEMELE Schum.

Semele (?) dalli sp. nov. Pl. IV, fig. 5.

This specimen is somewhat more triangular than the *Semelidæ* usually are, but its sculpturing and the possession of a shallow sinus parallel to the anterior margin make it resemble the form described by Dr. Dall in his "A Subtropical

Miocene Fauna in Arctic Siberia." *Proceed. U. S. Nat. Museum*, Vol. XVI, pp. 471–478.

Locality: Limestone beds on Loboo River, Batangas Province.
Age: Younger Miocene.

Table No. IV presents in brief the writer's present knowledge of the distribution and relationships of the fossils described and figured. It is well understood that much more might be stated if a completer acquaintance with the literature were possible. As paleontological work in other portions of the Islands is in progress, it is deemed best at the present time to forego further comment on the material here presented.

TABLE IV.—*Showing relationship and distribution of the Batangas fossils.*

No.	Name of fossil.	Plate.	Found in Tertiary of adjacent countries.	Relationship.	Localities in Philippines.
1	Vicarya callosa[a] Jenk.	III	Java, Japan (Miocene.)	Vicarya verneuili D'arch. (Miocene of India).	Batangas Province, Cebu, and northern Luzon.
2	Tapes lobooënsis sp. nov.	III	----------	Tapes rimosa Phil. (Miocene, Java).	Batangas.
3	Strombus javanus Mart. var. Semperi var. nov.	III	----------	Strombus javanus Mart. (Miocene, Java).	Do.
4	Macoma rosariana sp. nov.	III	----------	M. nasuta Conrad (Pleistocene, California).	Do.
5	Pteropsis? bullata sp. nov.	III	----------	----------	Do.
6	Arca nodosa var. batanensis.	III	----------	A. nodosa K. Mart. (?) (Miocene, Java).	Batan Island; Batangas.
7	Tapes sp. indet	III	----------	----------	Batangas.
8	Lucina sp. indet	III	----------	Similar casts in Benguet and Cebu.	Do.
9	Cycloseris hidalgi sp. nov.	IV	----------	C. dicipiens Mart. (Miocene, Java).	Batangas; Benguet.
10	Balanophyllia hyllia	IV	----------	----------	Batangas.
11	Turbo borneënsis Bttg.	IV	Borneo (Eocene)	----------	Batangas; Benguet in Luzon and Cebu.
12	Semele (?) dalli sp. nov.	IV	----------	----------	
13	Nerita punctata sp. nov.	IV	----------	N. rumphi Recluz (Miocene, Java).	
14	Orbitoides martini sp. nov.	IV	The genus is distributed from New Hebrides to Japan.	----------	Cebu; Batangas.
15	Drillia weberi, sp. nov.	IV	----------	----------	Batangas.
16	Cypraea paniculus? Bttgr.	IV	Borneo (Eocene)	----------	Do.

[a] *Cerithium nodulosum* living in Philippine waters is probably closely related to *V. callosa*. Likewise *C. vulgatum* from southern Europe, West Africa, and Cape of Good Hope.

ILLUSTRATIONS.

PLATE I.

Diagrammatic section across portion of Batangas Province.

PLATE II.

General map of portion of Batangas Province, showing the Loboo Mountains (from d'Almonte).

PLATE III.

(All figures slightly enlarged.)

1. *Vicarya callosa* Jenk.
2. *Tapes lobooënsis* sp. nov.
3. *Strombus javanus* var. *semperi* var. nov.
4. *Macoma rosariana* sp. nov.
5. *Pteropsis? bullata* sp. nov.
6. *Arca nodosa* var. *batancnsis*.
7. *Tapes?* sp. indet.
8. *Lucina* sp. indet.

PLATE IV.

(All figures slightly enlarged.)

1. *Cycloscris hidalgi* sp. nov.
2. Indet. (one of the *Eupsammidæ*).
3, 4. *Turbo borneënsis* Bttg.
5. *Semele* (?) *dalli* sp. nov.
6. *Orbitoides martini* sp. nov.
7. *Orbitoides martini* (end view).
8. *Nerita punctata* sp. nov.
9. *Orbitoides martini* (enlarged six diameters, from drawing).
10. *Drillia weberi* sp. nov.
11. *Turbo borneënsis* (young form).
12. *Cypraea paniculus* (young form).
13. Internal cast of *Vicarya?*

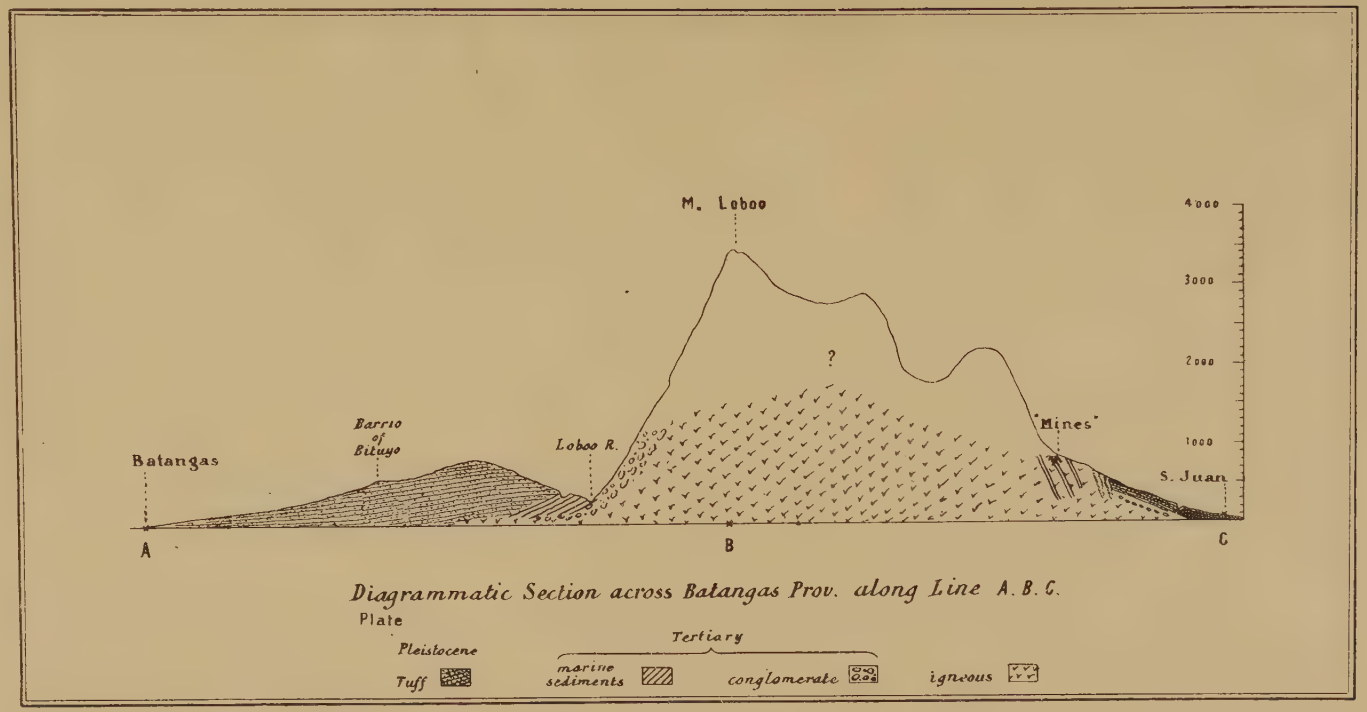
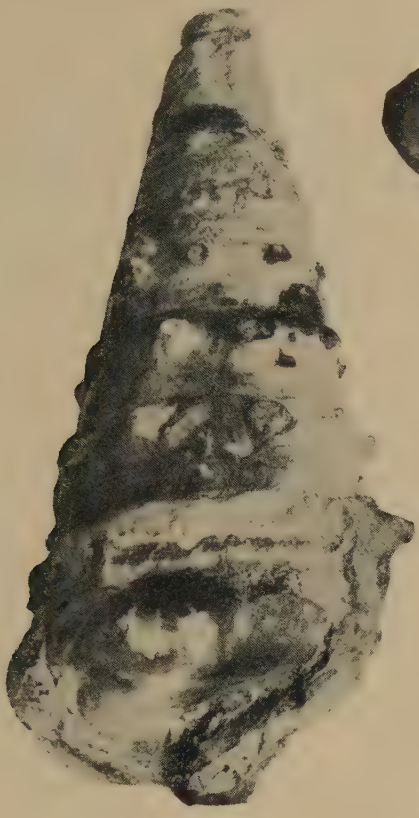

M. Loboo
4000
3000
2000
1000
?
Barrio of Bituyo
Batangas
Loboo R.
"Mines"
S. Juan
A
B
C
Diagrammatic Section across Batangas Prov. along Line A.B.C.
Plate
Pleistocene
Tertiary
Tuff
marine sediments
conglomerate
igneous

PLATE I.

LAGUNA DE BAY
Calamba
Los Baños
Bay
Pila
Magdalena
Calauang
Nagcarlang
Lilio
Banadero
Sta Anastasia
Sto Tomas
Tanauan
Alaminos
Pablo
M. S. Cristobal
1612
Bilina
Talaga
Tumbaga
Concepcion
Lagunas
Lipa
Imus
Malvar
Taal
Taysan
Batangas
Bauan
Candelaria
Tayabas
Cuenca
S. Jose
Rosario
Ibaan
S. Juan
Bilaran
Gico
Calecanto
Sinturis o Lanay
Mataas na Lupa
Malubo
Lagadlad
Bolbok
Sabuquin
Calabcab
Pedro
Magpit
Mababangonan
Pinahan
Pamucan
Talingan
Layan
Icolbon
Lobo
Loboo
1052
Pta de Arena
Pta Talagib
Pta Malagundi o Calban
Pta Malubrigo
Pta Punos o Loboo
MAP SHOWING
LOBOO MOUNTAINS-BATANGAS PROVINCE
Scale 1:400000
I.A VERDE

PLATE II.



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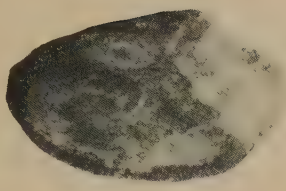

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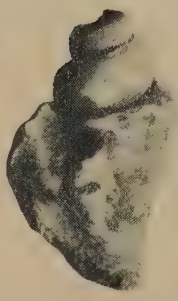

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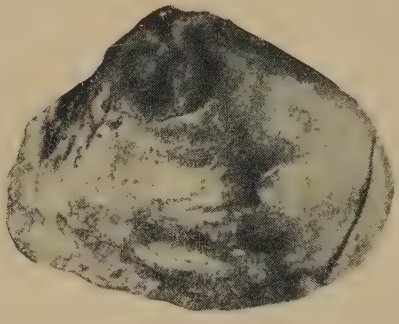

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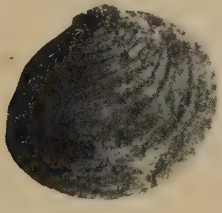

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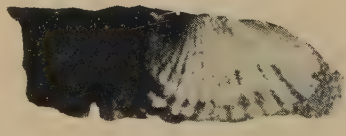

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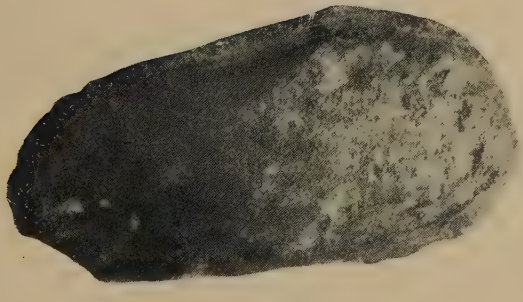

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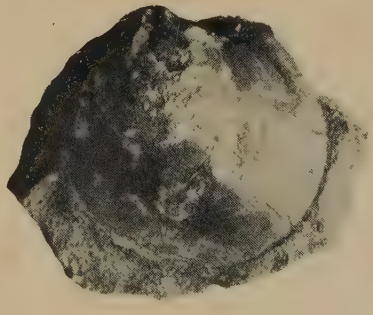

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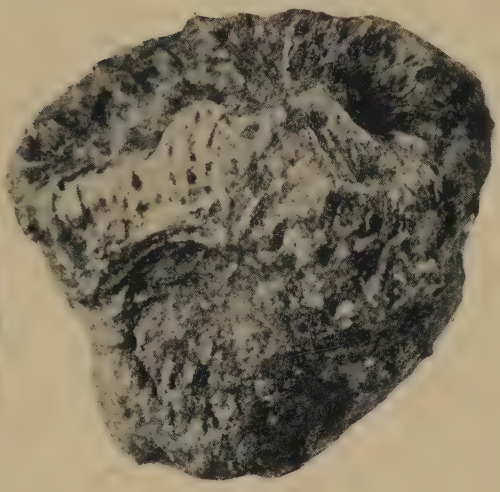
PLATE III.

1



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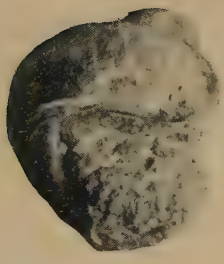

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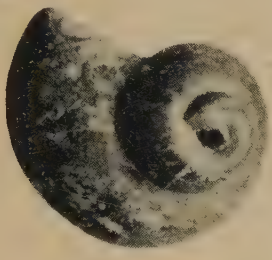

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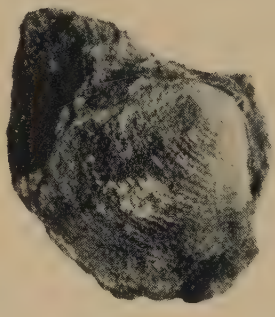

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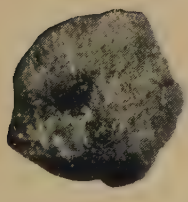

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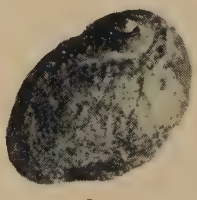

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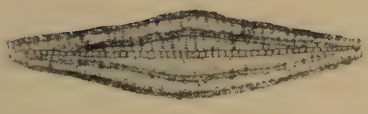

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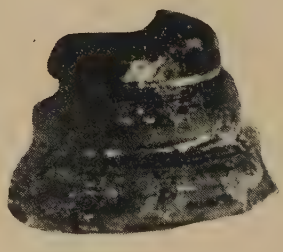

13

PLATE IV.

THE VEGETATION OF THE LAMAO FOREST RESERVE, II.

(CONCLUDED FROM PAGE 431.)

By H. N. WHITFORD.

(*From the botanical section of the Biological Laboratory, Bureau of Science.*)

III. THE DIPTEROCARPUS-SHOREA FORMATION.

On the south side of the Reserve there is a characteristic type of vegetation between the two hundred and fiftieth and four hundred and fifth meter contour lines; on the north, as shown by the map, the type almost entirely disappears. Over 15 per cent of the trees belong to one species, *Dipterocarpus grandiflorus* (apitong). So characteristic is this species that it was thought advisable to separate the forest where it is encountered into a distinct formation, giving it the name of the two principal species of *Dipterocarpaceæ* which are found there. (Pls. XXIV and XXVIII.)

Description of Table XVII.[43]

The plot is situated at an altitude of 340 meters. It is on the top and slopes of a ridge and comprises an area of approximately 8,325 square meters.

TABLE XVII.

Name of plant.	A.	B.
1. Dipterocarpus grandiflorus	182	15.7
2. Shorea polysperma	134	11.5
3. Memecylon edule	94	8.1
4. Aporosa sphaeridophora	81	7.0
5. Ternstroemia toquian	66	5.7
6. Diospyros pilosanthera	59	5.1
7. Santiria nitida	52	4.5
8. Callophyllum wallichianum	46	4.1
9. Shorea contorta	41	3.5
10. Cyclostemon microphyllum	30	2.6
11. Eugenia glaucicalyx	26	2.2
12. Cinnamomum mercadoi	23	2.0
13. Aporosa symplocosifolia	22	1.9
14. Semecarpus perrottetii	22	1.9
15. Hopea acuminata	20	1.7
16. Quercus sp	17	1.6
17. Kayea paniculata	15	1.3
18. Litchi philippinensis	15	1.3
19. Plectronia viridis	12	1.0
20. Euphoria cinerea	12	1.0
21. Shorea guiso	12	1.0

[43] The data upon which Table XVII is based were gathered by T. E. Borden, inspector in the Bureau of Forestry.

TABLE XVII—Continued.

Name of plant.	A.	B.
22. Ellipanthus luzoniensis	10	(a)
23. Symplocos oblongifolia	10	
24. Vatica mangachapoi	10	
25. Baccaurea tetrandra	10	
26. Eugenia sp	8	
27. Pandanus luzonensis	8	
28. Anisoptera vidaliana	6	
29. Calophyllum whitfordii	6	
30. Gonocaryum tarlacense	6	
31. Ormosia calavensis	6	
32. Knema heterophylla	6	
33. Excoecaria philippinensis	5	
34. Dimorphocalyx longipes	4	
35. Kopsia longiflora	4	
36. Litsea luzonica	4	
37. Litsea fulva	4	
38. Myristica philippensis	4	
39. Sideroxylon duclitan	4	
40. Talauma villariana	4	
41. Antidesma edule	3	
42. Ficus sp	3	
43. Aglaia harmsiana	2	
44. Champereia cumingiana	2	
45. Eugenia sp	2	
46. Eugenia sp	2	
47. Grewia stylocarpa	2	
48. Mangifera altissima	2	
49 Pygeum latifolium	2	
50. Shorea sp	2	
51. Sterculia brevipetiolata	2	
52. Linociera sp	2	
53. Unona clusiflora	2	
54. Aglaia bordenii	1	
55. Albizzia procera	1	
56. Ardisia philippinensis	1	
57. Artocarpus communis	1	
58. Buchanania florida	1	
59. Citrus hystrix	1	
60. Cyathocalyx globosus	1	
61. Dipterocarpus vernicifluus	1	
62. Ficus sp	1	
63. Guioa sp	1	
64. Ixora sp	1	
65. Ixora sp	1	
66. Memecylon sp	1	
67. Michelia parviflora	1	
68. Mitrephora ferruginea	1	
69. Pahudia rhomboidea	1	
70. Palaquium tenuipetiolatum	1	
71. Randia sp	1	
72. Shorea sp	1	
73. Voacanga sp	1	
74 to 85 (unknown species)	12	
Total (85)	1,160	

[a] The following have less than 1 per cent.

Description of Table XVIII.

This table covers four plots in various situations in the *Dipterocarpus-Shorea* formation. A, a plot of 600 square meters situated at the junction of the main ridge with a side one at an altitude of 410 meters. B, a plot in a partially open place on a ridge at an altitude of 330 meters; it comprises 450 square meters. C, a plot of 750 square meters at the junction of a side ridge with the main one at an altitude of 300 meters. D, a small plot comprising 300 square meters at 260 meters' altitude on a gentle slope. E, total number of trees of each species in all the plots. F, percentage of the same.

TABLE XVIII.

Name of plant.	A.	B.	C.	D.	E.	F.
1. Dipterocarpus grandiflorus	12	1	28	30	71	18.4
2. Calophyllum wallichianum	8	4	27	3	42	10.9
3. Shorea polysperma	11	5	11	7	34	8.8
4. Shorea contorta	3	11	6	1	21	5.4
5. Santiria nitida	7	6	4		17	4.4
6. Diospyros pilosanthera		6	3	6	15	3.8
7. Litsea fulva	1	7	7		15	3.8
8. Anisoptera vidaliana		2	7	4	13	3.3
9. Baccaurea tetrandra	6	2	2	3	13	3.3
10. Cinnamomum mercadoi	2	2	8		12	3.1
11. Cyclostemon microphyllum		2	9		11	2.8
12. Semecarpus perrottetii	4	3	1		8	2.0
13. Gonocaryum tarlacense		4	3		7	1.8
14. Eugenia glaucicalyx	1	1	3	1	6	1.5
15. Hopea acuminata	1	3	1	1	6	1.5
16. Euphoria cinerea	3		2		5	1.3
17. Kopsia longiflora		3	2		5	1.3
18. Ormosia calavensis	3	2			5	1.3
19. Atalantia disticha	1	1	2	0	4	1.0
20. Aporosa sphaeridophora	4				4	1.0
21. Dipterocarpus vernicifluus		2	2		4	1.0
22. Ellipanthus luzoniensis	1	2	1		4	1.0
23. Kayea paniculata	2			2	4	1.0
24. Myristica philippensis		3	1		4	1.0
25. Unona clusiflora	2		2		4	1.0
26. Aporosa symplocosifolia	1	2			3	(a)
27. Buchanania florida	3				3	
28. Dimorphocalyx longipes			3		3	
29. Grewia stylocarpa	1	1	1		3	
30. Litchi philippinensis		2	1		3	
31. Neolitsea vidalii			1	2	3	
32. Aglaia bordenii	2				2	
33. Casearia cinerea		2			2	
34. Eugenia sp			2		2	
35. Eugenia sp		2			2	
36. Litsea luzonica	1	1			2	
37. Palaquium tenuipetiolatum	1			1	2	
38. Parkia roxburghii		2			2	
39. Plectronia sp			2		2	
40. Quercus sp	2				2	
41. Reinwartiodendron merrillii	2				2	
42. Strombosia philippinensis	2				2	

[a] Less than 1 per cent.

TABLE XVIII—Continued.

Name of plant.	A.	B.	C.	D.	E.	F.
43. Zizyphus zonulatus		2			2	
44. Antidesma edule	1				1	
45. Casearia fuliginosa		1			1	
46. Champereia cumingiana			1		1	
47. Eugenia sp.			1		1	
48. Ficus ruficaulis		1			1	
49. Garcinia binucao			1		1	
50. Mangifera altissima		1			1	
51. Mitrephora lanotan			1		1	
52. Pithecolobium acle		1			1	
53. Pygeum latifolium			1		1	
54. Talauma villariana		1			1	
55. Ternstroemia toquian		1			1	
Total	88	92	147	61	388	

It will be seen from Tables XVII and XVIII that three members of the *Dipterocarpaceæ,* namely, *Dipterocarpus grandiflorus, Shorea polysperma,* and *S. contorta,* comprise 31.6 per cent of all the trees in the plots measured. With the exception of *Calophyllum wallichianum, Santiria nitida, Eugenia glaucicalyx,* and a few others, these trees make up nearly the whole of the upper story vegetation. Attention has already been called to the fact (see p. 420) that in this formation these trees in places form a similar crown class and that in correspondence with this there is a less development of board roots. (See Pl. XXIV.)

Trees which may reach a crown class slightly lower than the *Dipterocarpaceæ* are *Ternstroemia toquian, Diospyros pilosanthera, Litsea sp., Cinnamomum mercadoi,* and others. Prominent, because of the three striking board roots, is *Eugenia glaucicalyx.* (See Pls. XXII and XXVIII.) A reference to the tables descriptive of the other formations will show that with the exception of *Dipterocarpus grandiflorus* all the species found in this one are also present in others. In this plot *Parkia roxburghii,* with two trees, reaches its highest altitude. *Albizzia procera,* another species of the *Bambusa-Parkia* formation, is likewise represented by one specimen and the upper limits of *Pterocymbium tinctorium* and *Pithecolobium acle* are also found.

On the other hand, species which become more prominent in the next formation higher up the mountain are introduced for the first time. Prominent among these are *Ternstroemia toquian, Plectronia viridis, Symplocos oblongifolia,* and *Excoecaria philippinensis.* In this formation *Anisoptera vidaliana* occupies a subordinate position and it entirely disappears from the forests a short distance above its upper limits.

The presence of *Dipterocarpus grandiflorus* in a narrow belt at this altitude, where it becomes the most important tree, is undoubtedly due to more favorable climatic conditions than exist below this altitude. Why

it should not be represented by more specimens lower down [44] and why it disappears almost entirely on the ridge leading to Limay Peak is not known. The explanation of its scarcity in the latter locality is probably correlated with the extension of the *Bambusa-Parkia* formation higher up the mountain in this situation. That the heat of the low country is not too great for it to flourish is evidenced by the fact that on the east coast of Luzon, where the dry season is less pronounced, it descends nearly to sea level.

The topography of this formation is similar to that of the previous one discussed—i. e., it shows alternating prominent ridges and valleys. With the exception of its non-occurrence on the steep slopes, where the vegetation is thin and in the beds of the river canyons, *Dipterocarpus* itself is not confined to any particular topographic type. At the extreme upper limits of the apitong zone is a sharp knob where all the soil has been washed off, leaving the half-disintegrated volcanic rock exposed on the surface. On this area, out of 60 trees noted, 18 were *Quercus sp.;* 11, *Vatica mangachapoi;* 10, *Shorea polysperma;* 9, *Eugenia pallida;* 5, *Symplocos oblongifolia,* and the remainder *Dipterocarpus grandiflorus, Ternstroemia toquian, Aporosa symplocosifolia,* and *Plectronia viridis.* All these species in this situation have much reduced leaves and the trees show a tendency to become dwarfed. This plot is the lowest place which was observed on the mountain, where exposure to wind dwarfs the trees of the forest. The climbing bamboo (*Dinochloa tjankorreh*) is characteristic on the open places on steep slopes. No other bamboos are present in the formation. Young trees of the *Dipterocarpaceæ* with *Memecylon edule, Aporosa sphæridophora, Diospyros pilosanthera, Uvaria alba, Claoxylon rubescens, Codiaeum luzonicum, Leea philippinensis, Litsea luzonensis, Dracaena augustifolia,* and *Tabernaemontana pandacaqui* form the undergrowth.

In its response to the xerophytic conditions of the dry season, this formation differs from the *Anisoptera-Strombosia* one in having fewer deciduous trees. Isolated specimens of *Parkia roxburghii* are about the only individuals which shed their leaves completely during a portion of the dry season, but nearly all the trees show a thinner foliage. *Dipterocarpus grandiflorus* completely changes its leaves during January and February, but simultaneously with the dropping of the old, new ones take their place. At this season of the year the thick bed of dead leaves on the ground, the large, red, bud scales appearing with the new leaves and the large, sweet-scented flowers of this species accentuate its numerical importance. The ground itself is so completely covered with fallen foliage that this characteristic, together with the thin undergrowth, reminds one strikingly of the forests of temperate regions in the autumn. Plates XXIV and XXVIII will give some idea of the gen-

[44] Only one was noted in the *Anisoptera-Strombosia* formation and none were observed above an altitude of 450 meters.

eral appearance of the forest. In its other ecological characteristics the *Dipterocarpus-Shorea* resembles the *Anisoptera-Strombosia* formation.

Summary.—1. Over 30 per cent of the *Dipterocarpus-Shorea* formation is composed of members of the *Dipterocarpaceæ*.

2. Corresponding with the greater rainfall, less saturation deficit and less heat, this formation, in contrast with those lower down the mountain side, is less xerophytic. This is shown by the almost complete absence of deciduous trees and by the greater leaf display among the evergreens during the dry season.

3. The formation, as a whole, has a more regular profile.

4. In other ecological respects the formation resembles the *Anisoptera-Strombosia* formation.

5. For the first time a topographical situation is encountered where exposure brings about a tendency to dwarf the trees—a tendency which finds its best expression on the exposed ridges higher up the mountain.

IV. Shorea-Plectronia Formation.

In striking contrast with the formation in which over 30 per cent of the larger tree species are members of the *Dipterocarpaceæ* is the one immediately above it in which this family is represented by only 16 per cent of the total number of trees over 4 meters in height. Again, an under story vegetation is represented by a number of species. Among the larger of these, the genus *Shorea* stands first and the rubiaceous *Plectronia viridis* is typical of a number of about the same height and having the same ecological characteristic—that is, an ability to withstand a considerable amount of shade, and therefore this has been called the *Shorea-Plectronia* formation. In extent it lies approximately between the 450 and 900 meter contour lines. Its upper limits are marked by a rather sudden restriction of the *Dipterocarpaceæ*.

Description of Table XIX.

Plots in Shorea-Plectronia formation.—A, a plot on a level bench of a side ridge leading from the main ridge to the Lamao river. It comprises an area of 675 square meters. B, a plot starting at an altitude of 675 meters and running through a vertical distance of 30 meters. The slope is about 25° and the area 1,440 square meters. It is on the same ridge as A. Plots C, D, E, F, and G, each extending through a vertical distance of 30 meters, represent portions of a narrow side ridge leading directly to the river at right angles to the one on which are A and B. C, is on a slope of 42° and has an area of approximately 252 square meters; D, on a gradient of 40° and with an area of 336 square meters; E, one of 44°, and it represents an area of 360 square meters; F, is a still steeper slope of 45° on a narrow ridge between two ravines. It has an approximate area of 250 meters. A canyon to the right of it has a depth of 18 meters with perpendicular sides. G, is on a very steep and unstable slope (over 45°); it has an estimated area of 300 square meters and ends at the junction of two canyons. The first line tabulates trees over 4 meters in height; the second, those under 4 meters; H, is the total of trees over, and I of those under 4 meters; J, represents the percentage in all plots of trees over 4 meters.

TABLE XIX.

Name of plant.	A.	B.	C.	D.	E.	F.	G.	H.	I.	J.
1. Plectronia viridis	10	43	20	25	17			115		11.5
	8	11	9	13	22				43	
2. Shorea polysperma	8	16	20	28	23	6		101		10.1
			7				1		Many.	
3. Memecylon edule	13	41	5		2			61		6.1
	9		5	1	9	1			Many.	
4. Calophyllum whitfordii	4	16	8	17	9	2	1	57		5.7
	3			8	6	8			Many.	
5. Aporosa simplocosifolia	3	16	5	11	10	5	3	53		5.3
	1	4	1	12	19	7	1		45	
6. Hopea acuminata	8	10	4	6	10	4	1	43		4.3
	3		3	6	12					
7. Thea montana	2	25	1	6	6	1		41		4.1
	3	22	12	10	10				57	
8. Quercus sp	2	7	5	17	5		1	37		3.7
	5								Many.	
9. Eugenia glaucicalyx	11	17	1	2	1	1		33		3.3
									Many.	
10. Ternstroemia toquian	5	8	2	8	5		4	32		2.3
		4			10	2			16	
11. Shorea contorta	1	15	5	1	1		2	25		2.5
	4	5	5	1			1		16	
12. Acer philippinum		3	11	6	8	1		29		2.4
	1	5	22	25	10	2			45	
13. Eugenia acuminatissima	4	5	6	2	1		5	23		2.3
	5	4		6	7	1			23	
14. Cinnamomum mercadoi	2	3		7	4	1		17		1.7
	4	2		2					8	
15. Cyclostemon microphyllum	2	10	1		3	1		17		1.7
	2	2			1				5	
16. Symplocos oblongifolia		2	2	9	3			16		1.6
				8	7				15	
17. Unona clusiflora	3	7	1	1	3			15		1.5
		5	8		2				15	
18. Aporosa sphaeridophora		11	2	2				15		1.5
		7		4					11	
19. Diospyros pilosanthera		7	1		1	2	3	14		1.4
	1	3	2		4		6		16	
20. Ardisia marginata	6	4	3					13		1.3
	5	5	9	2	2	2	4		29	
21. Casearia solida		1					11	12		1.2
							13		13	
22. Crypteronia cumingiana					3	7	2	12		1.2
									7	
23. Buchanania florida				1	2	3	5	11		1.1
					2	1	1		4	
24. Baccaurea tetrandra					1	1	8	10		1
			1		1	1	8		11	
25. Semecarpus perrottetii					5	3	2	10		1
					3	3	3		9	
26. Itea macrophylla					5	5		10		1
					5	2			7	
27. Eugenia pallida	2	7			1			10		1
		1	3						4	
28. Santiria nitida	1	4	1	1	1	1		9		.9
						1			1	
29. Eugenia sp	4	3			1			8		.8
	3	1							4	
30. Antidesma? sp	4	3	1					8		.8
		4	1						5	
31. Agathis philippinensis	3	3		1	1			8		.8
		1		1					2	
32. Eugenia cinnamomea							7	7		.7
							1		1	
33. Glochidion sp					3	4		7		.7

TABLE XIX—Continued.

Name of plant.	A.	B.	C.	D.	E.	F.	G.	H.	I.	J.
34. Guioa perrottetii	2	4	1 2	2 2	2 5	1		6	15	0.6
35. Dipterocarpus vernicifluus	2	4 4						6	4	.6
36. Gordonia fragrans	1	3	2					6		.6
37. Ellipanthus luzoniensis			1	3			1	5		.5
38. Eurya acuminata			3	1 4	1			5	4	.5
39. Polyalthia barnesii							4 5	4	5	.4
40. Eugenia sp				4 3				4	3	.4
41. Eugenia bordenii			1		2	1 2		4	2	.4
42. Eugenia whitfordii		2 1					2 1	4	2	.4
43. Timonius arborea					3	1 1		4	1	.4
44. Litsea luzonica	4	2 9			2	1	1	3	16	.3
45. Astronia rolfei						3		3	Many.	.3
46. Polyosma philippinensis	2	1 3	1					3	4	.3
47. Symplocos ferruginea	2 1			1	1			3	2	.3
48. Englehardtia subsimplicifolia				2 1	1			3	1	.3
49. Randia whitfordii	1						3	3	1	.3
50. Eugenia sp						1	2	3		.3
51. Euphoria cinerea						2	6	2	6	.2
52. Randia fitzalani		1 1	1		1			2	2	.2
53. Podocarpus blumei		1 3					1	2	3	.2
54. Eugenia sp					2 1			2	1	.2
55. Champereia cumingiana		1		1	1			2	1	.2
56. Canarium villosum						2		2		.2
57. Atalantia disticha		1	1					2		.2
58. Myrica rubra		1		2 1				2	2	.2
59. Endiandra coriacea							2	2		.2
60. Arthrophyllum ahernianum					2			2		.2
61. Pygeum latifolium	1					1		2		.2
62. Helicia philippinensis					2			2		.2
63. Palaquium tenuipetiolatum		1					1	2		.2
64. Cyclostemon monospermus	2							2		.2
65. Aglaia bordenii							2 3	2	3	.2
66. Scolopia luzonensis		1		1				2		.2

TABLE XIX—Continued.

Name of plant.	A.	B.	C.	D.	E.	F.	G.	H.	I.	J.
67. Linociera coriacea		1						1		0.1
						7	1		8	
68. Euphorbiaceæ sp						1		1		.1
						5			5	
69. Casearia cinerea							1	1		.1
							2		2	
70. Antidesma lucidum			1					1		.1
			1						1	
71. Garuga floribunda					1			1		.1
					1				1	
72. Knema heterophylla	1							1		.1
		1							1	
73. Litchi philippinensis							1	1		.1
							1		1	
74. Litsea sp		1						1		.1
	1		1						2	
75. Planchonia spectabilis							1	1		.1
							1		1	
76. Antidesma leptocladum							1	1		.1
77. Ardisia boissieri					1			1		.1
78. Eugenia sp							1	1		.1
79. Ficus sp						1		1		.1
80. Ficus hauili?				1				1		.1
81. Ficus sp	1							1		.1
								1		.1
82. Laportea luzonensis							1	1		.1
83. Nauclea philippinensis					1			1		.1
84. Pavetta barnesii		1						1		.1
85. Machilus philippinensis	1							1		.1
86. Saurauia subglabra					1			1		.1
87. Shorea guiso							1	1		.1
88. Turpinia pomifera							1	1		.1
89. Villebrunea trinervis						1		1		.1
90. Unknown species										
91. Unknown species			2							.2
Total	111	305	118	168	172	63	100	100		100.0

Description of Table XX.

These plots are in various physiographic situations in the *Shorea-Plectronia* formation. A is in the basin at the head of a ravine, one side of which is open. The plot is on a very slight slope, comprises an area of 770 square meters and is at an altitude of 528 meters. B is on the main ridge leading to the mountains, here the ridge is broad, with a gentle slope; the plot has an area of 640 square meters and is situated at an altitude of 570 meters. C is on an exposed slope of the main ridge, with an incline of 25°. It has an area of about 610 square meters and is at an altitude of 500 meters. D is on a level ridge at an altitude

of 460 meters and comprises an area of approximately 620 square meters. E, totals; F, percentage.

TABLE XX.

Name of plant.	A.	B.	C.	D.	E.	F.
1. Diospyros pilosanthera	8	9	5	4	26	7.9
2. Shorea contorta	7	5		13	25	7.6
3. Litsea luzonica	9	5	1	2	17	5.2
4. Calophyllum whitfordii		3	10	2	15	4.6
5. Memecylon edule	2	5	8		15	4.6
6. Cinnamomum mercadoi		8	3	3	14	4.3
7. Shorea polysperma	7		2	4	13	4.0
8. Baccaurea tetrandra	8	2		2	12	3.7
9. Ternstroemia toquian		5	5	1	11	3.4
10. Santiria nitida	4	1	3	2	10	3.1
11. Eugenia sp	9				9	2.7
12. Aporosa sphaeridophora	1	1		6	8	2.4
13. Litsea sp		5	1	3	8	2.4
14. Ardisia boissieri		4	2	1	7	2.1
15. Calophyllum wallichianum			4	3	7	2.1
16. Eugenia sp	5	2			7	2.1
17. Hopea acuminata	1	5	1		7	2.1
18. Plectronia sp		4	3		7	2.1
19. Thea montana			7		7	2.1
20. Eugenia acuminatissima	1	5			6	1.8
21. Plectronia viridis	6				6	1.8
22. Semecarpus perrottetii		3		3	6	1.8
23. Eugenia sp		5			5	1.5
24. Pheanthus cumingii			1	4	5	1.5
25. Aporosa symplocosifolia		2	2		4	1.2
26. Dipterocarpus vernicifluus	4				4	1.2
27. Acronychia laurifolia		3			3	(a)
28. Cryptocarya luzoniensis		3			3	
29. Eugenia cinnamomea		3			3	
30. Gonocaryum tarlacense			1	2	3	
31. Kayea paniculata	1			2	3	
32. Quercus sp	1			2	3	
33. Symplocos elmeri		1		2	3	
34. Unona clusiflora		2		1	3	
35. Buchanania florida			2		2	
36. Dysoxylum turczinanowii				2	2	
37. Goniothalamus sp		2			2	
38. Lagerstroemia speciosa	2				2	
39. Laportea luzonensis	2				2	
40. Neolitsea vidalii		1		1	2	
41. Podocarpus blumei		2			2	
42. Tabernaemontana pandacaqui	2				2	
43. Vatica mangachapoi			2		2	
44. Aglaia bordenii	1				1	
45. Antidesma edule	1				1	
46. Ardisia philippinensis				1	1	
47. Atalantia disticha			1		1	
48. Anisoptera vidaliana			1		1	
49. Casearia solida		1			1	
50. Champereia cumingiana			1		1	
51. Cyclostemon microphyllum				1	1	
52. Dimorphocalyx longipes			1		1	

[a] Less than 1 per cent.

TABLE XX—Continued.

Name of plant.	A.	B.	C.	D.	E.	F.
53. Eugenia sp	1				1	
54. Eugenia sp				1	1	
55. Eugenia glaucicalyx			1		1	
56. Fagara integrifoliola				1	1	
57. Helicia philippinensis		1			1	
58. Litchi philippinensis			1		1	
59. Euphorbiaceae sp	1				1	
60. Mangifera altissima	1				1	
61. Linociera coriacea		1			1	
62. Podocarpus neriifolius		1			1	
63. Pygeum latifolium				1	1	
64. Sterculia brevipetiolata				1	1	
65. Shorea guiso				1	1	
66. Sideroxylon duclitan			1		1	
67. Tarrietia sylvatica			1		1	
Total					327	

Composition of the forest.—An examination of Tables XIX and XX will show that among the trees of the upper crown class the *Dipterocarpaceæ,* represented by *Shorea polysperma, S. contorta, Hopea acuminata,* and scattered specimens of *Dipterocarpus vernicifluus, Anisoptera vidaliana, Shorea guiso,* and *Vatica mangachapoi,* comprise about 16.5 per cent of all and reach to a height of 25 to 30 meters. Species of *Eugenia,*[45] although present in the lower formation, become more prominent in this one. In some instances they reach to the height of the dipterocarps, but usually they are considerably lower in stature; about 10 per cent of the forests are composed of species of *Eugenia* and among others having individuals of this class are *Quercus* (about two species), *Calophyllum whitfordii, C. wallichianum,*[46] *Santiria nitida, Agathis philippinensis, Gordonia fragrans,* and isolated specimens of other ones. *Agathis philippinensis* (almaciga) of the *Pinaceæ* reaches huge dimensions, being in many instances 40 meters in height and nearly 2 meters in diameter. (See Pl. XXV.)

Memecylon edule, Diospyros pilosanthera, Aporosa symplocosifolia, Thea montana, Acer philippinum, and *Litsea luzonica* are the principal representatives of the under-story species. Certain families, some of which are present in the lower formations, now occur with a greater number of species and individuals. Among these, species of *Rubiaceae* stand out prominently. Besides *Plectronia viridis,* which gives a decided tone to the undergrowth, there are *Timonius arborea, Randia whitfordii, R. fitzalani,* and *Nauclea philippinensis,* which reach a height of over 4

[45] The species of *Eugenia* are difficult to distinguish by leaf specimens, hence specific determinations have not been made in all instances.

[46] The two species of *Calophyllum* overlap each other in their distribution at the lower limits of this and the upper limits of the previous formation.

meters, although they seldom are taller than 8. *Rubiaceæ* which do not reach above 4 meters occur as scattered specimens of the genera *Knoxia* and *Urophyllum,* which are better represented on the exposed ridges at greater altitudes.

Besides the larger trees of the *Theaceæ,* namely, *Gordonia fragrans* and *Ternstroemia toquian,* the smaller one, *Thea montana* is very common as undergrowth. *Memecylon edule* of the *Melastomataceæ,* which is also conspicuously encountered in all three formations below that of the *Shorea-Plectronia,* is very common in this portion of the Reserve; indeed, here it reaches its best development in size and numbers.

Relation of the composition of the forest to topography.—The variation in the composition of the forest, just as is the case in the formations previously discussed (excepting in the parang types, which are due to artificial conditions), depends in the main on the physiographic situation. The topography in this situation is rougher than it is in the formations found at lower altitudes. This prevents the vegetation from reaching the luxuriant condition which it would have in a similar climate but with a more stable topography; that is, at a point nearer base level with its accompanying conditions. Again, as compared with lower situations, the higher altitude of this formation renders any exposed position more subject to the influence of winds, and thus a tendency toward a dwarfed condition in the vegetation is brought about. It has already been shown that the vegetation of a ridge peak (see p. 641) in the *Dipterocarpus-Shorea* formation is partially dwarfed, and for Mariveles Mountain this tendency reaches its climax in one to be discussed below and designated as the *Eugenia-Vaccinium,* but in comparison with the latter it is much less pronounced in the formation under discussion. At an altitude of 760 meters there appears an exposed ridge peak which has a thin soil and a strikingly xerophytic vegetation, which contrasts with the more protected one found in a slightly lower saddle near by. Here members of the *Dipterocarpaceæ* are entirely absent, although present in other situations at the same altitude within the formation. *Ternstroemia toquian, Thea montana, Quercus* sp., *Eugenia robertii,* and other species which are here encountered show a leaf surface much reduced from that which they present when they grow at an identical elevation in more favorable positions. The rutaceous *Acronychia laurifolia* with hard, and during the dry season, partially deciduous leaves, the rubiaceous *Tricalysia* sp., and the melastomaceous *Memecylon affine,* both shrubby and with hard leaves, are among the common forms met with in similar physiographic situations at a greater altitude on the mountain. Mingled with the above may be found *Scolopia luzonensis, Atalantia disticha,* and *Buchanania florida,* all found in xerophytic positions in the *Anisoptera-Strombosia* formation. *Buchanania* is especially marked by its very much reduced leaves. (Pl. XLIII, A). *Sterculia montana* is the only tree noted which for

a few days during the dry season was completely deciduous. Another plot, on a level bench of the main ridge at the same altitude and in the same physiographic situation as that of A, Table XIX, has a much more xerophytic and open vegetation than it would be expected to have, the difference apparently being caused by its greater exposure to the wind. Again, on a slope of 25° on the main ridge a vegetation exists which reminds one very much of that of the *Dinochloa* parang of the lower altitudes. Here *Dinochloa tjankorreh* is found growing together with species of *Calamus,* other procumbent lianas, and small trees such as *Casearia solida, Dysoxylon turczinanowii* and others. Plot B, Table XIX, has the same slope and depth of soil and although at the same altitude, is much less exposed. Plot C, Table XX, compares very favorably with Plot B, Table XIX, in all particulars excepting that the former is much more subject to the sweep of the winds; as a consequence it has a less mesophytic vegetation and members of the *Dipterocarpaceæ* are almost absent. In Plot C, Table XX, *Anisoptera vidaliana* reaches its highest altitude noted on the Reserve. The examples which have been cited will suffice to show that mere *exposure* has a tendency to make a less mesophytic and a more open vegetation irrespective of soil conditions. Other things being equal, the steeper the slope the more unstable and shallow will be the soil and as a consequence the greater the paucity of arborescent growth. A comparison of the plots analyzed in Table XIX emphasizes this fact. In this instance the situations of the plots are approximately the same in regard to exposure and altitude, but the slopes vary in degree from a level ridge-bench to those having an inclination of from 25° to over 45°. In those up to 40°, the members of the *Dipterocarpaceæ* together with other trees of the same crown class maintain the ascendency with the associated shade species. In slopes of over 40°, these trees become of less importance and when they do exist they seldom have developed beyond the sapling stage. They are associated with smaller and, during the dry season at least, less mesophytic or light-loving tree species, such as *Casearia solida, Buchanania florida, Semecarpus perrottii, Itea macrophylla,* and others, all of which are nearly absent where the slope is less steep. *Crypteronia cumingiana* reaches its best development on the edges of overhanging cliffs and probably because of a deep and wide spreading root system it is peculiarly fitted to maintain a foothold on unstable soil, although this tree is not found in places where the exposure to wind is great. (Pl. XXIX.) Precipitous slopes having an inclination of over 45°, contain but little arborescent vegetation; they usually form the sides of box canyons and are consequently more or less protected from drying influences of direct insolation. Ridges such as have been described, alternate with deep ravines the sides of which may be sufficiently steep to be classed as gorges. The slopes of the former are sparsely covered with forests and even when they are steeper than 50°,

may have shelves which contain trees the presence of which prevents more rapid erosion; the latter if unobstructed would render the slope so unstable as to become entirely treeless. The rocky, dry bed of these ravines is almost destitute of soil and correspondingly arboreal vegetation is entirely absent. Indeed, save for a scanty growth of ferns and mosses, vegetation of all kinds is wanting, although lichens are abundant on the rocks. A number of causes combine to bring about this condition. The lack of sufficient soil alone would operate against the invasion of plants from the slopes; during the dry season strong insolation increases the xerophytic condition of the habitat, and in the rainy season the torrents which periodically sweep through the bed of the ravine make the situation an exceedingly unstable one. However, small side ravines opening into the larger ones give a habitat of sufficient stability to support a rich vegetation. (See Pl. XXX.)

Nearly perpendicular eroding banks of the Lamao and other rivers show distinct types. If, as often is the case, these banks are exposed to strong insolation from one side, the vegetation during the dry season is confined to the small trees such as *Casearia solida, Brucea luzoniensis, Villebrunea trinervis, Leucosyke capitellata,* and the ferns, *Polystichum coniifolium, Polybotrya appendiculata, Asplenium laserpitiifolium,* and others. Other herbaceous plants are scattered specimens of *Begonia rhombicarpa* and species of *Selaginella.* During the rainy season these become represented by a greater number of specimens; indeed, in the more stable places on these walls, species of *Selaginella* and *Begonia* form more or less dense growths. In every instance where such banks are moistened by the seepage of underground water, the habitat is favorable for the development of mesophytic vegetation which is only slightly less luxuriant during the dry season. It is noteworthy that the vegetation occupying such habitats is ecologically remarkably uniform from the base to the top of the mountain. Plates XXXI and XXXII show two such situations at different altitudes, one in the *Anisoptera-Strombosia,* the other in the *Shorea-Plectronia* formation. The araceous *Schizmatoglottis rupestris* and *Begonia rhombicarpa* are common to both situations. Plate XXXIII shows two banks of the Lamao River at 500 meters' altitude; on the left there is no seepage and consequently but little vegetation excepting lichens; on the right there is seepage, with a resulting luxuriant growth of *Schizmatoglottis* and the urticaceous *Elatostema whitfordii.* The boulders in the river bed of the larger streams (see Pl. XXXIII) are entirely destitute of anything except crustaceous lichens and occasionally the fern, *Gymnopteris inconstans.* This latter with the creeping rubiaceous *Geophila herbacea, Trichomanes javanicum,* and a species of *Selaginella* constitute the vegetation of the wet rocks of the small but persistent streams, or in situations where the seepage is sufficient to maintain a wet atmosphere as well as a wet soil during the entire year. On the walls of narrow

box gorges, where seepage is constant during the dry season and where the insolation is low, delicate shade or mesophytic plants, usually ferns, are found. Here the tree fern, *Alsophila contaminans* is present and the very delicate *Lindsaya concinna* forms thick growths with *Microlepia pinnata, Nephrodium cuspidatum; Schizmatoglottis, Geophila,* and *Gymnopteris,* already mentioned as occurring in similar ecological situations, are also present. Two liverworts, *Anthoceros grandis* and one undetermined species of this group, are the only ones noted here. The temporarily less mesophytic conditions, due to steepness of the slopes or to exposure, or to both, and the temporary climax mesophytic vegetation due to unstableness of topography, dampness of soil, and low saturation deficit cited above are sufficient to show differences due to topographic situation.

The formation is almost devoid of level stretches which at the same time are not exposed. However, gentle slopes are present and where they are not near to the edge of ridges, they exhibit vegetative appearances as nearly akin to the stable climax condition as the climate is able to support. Such slopes are encountered in the small cirque-like basins situated at the heads of small streams, or still better on the south side of the Lamao, near the head waters of the Camayauan and Alangan rivers. It is here that the *Dipterocarpaceæ,* especially *Shorea polysperma, S. contorta,* and *Hopea acuminata,* reach their best development. Prominent, and reaching its largest dimensions (200 centimeters in diameter), is *Agathis philippinensis,* and, here also, the best growth of *Plectronia viridis, Podocarpus blumei,* and other associates of the second-story vegetation is encountered.

The epiphytic vegetation, corresponding with the more favorable climatic conditions, is more abundant in contrast with the formations lower down. The most conspicuous of the epiphytes is the bird's-nest fern, *Asplenium nidus.* (See Pl. XXXIII.) This is present in protected places, such as parts of the forest well back from the ridges, and on trees and rocks in the canyons of the Lamao River and its tributaries. The rubiaceous ant plant, *Myrmecodia echinata,* is also present on the limbs of the tall trees. Several undetermined orchids and the ferns *Davallia solida, Vittaria lineata, Anthrophyum reticulatum,* and *Polypodium meyenianum* are encountered, these species being more abundant in the gorges near the stream than they are on the ridges, but nearly all of these, as will be shown below, reach their best development at higher altitudes.

Summary.—1. In contrast with the lower formations, that of the *Shorea-Plectronia* shows a climate conducive to a more mesophytic vegetation. (See climatic data for Station 3, which is in this formation.)

2. Corresponding to these conditions the vegetation, as a whole, shows a less tropophytic character than that in the lower formations.

3. However, physiographic situations show a marked variety in the

nature of the vegetation. On exposed ridges and steep, exposed slopes it is decidedly less mesophytic and more tropophytic, although it is rare to find trees entirely without leaves. Box cañons and springy, protected slopes show delicate mesophytic plants.

4. Because of the unstability of the topography, the luxuriance of the vegetation is not as great as that which, were the physiography more stable, the climate would lead one to expect.

V. The Eugenia-Vaccinium Formation.

This formation includes that portion of the mountain lying above the 900-meter contour line.

Climate.—Its climate is distinguished from that existing below by two distinct features which, so far as plant life is concerned, are antagonistic to each other. These are *strong winds* and a *much higher relative humidity.* The former give rise to the peculiar, dwarfed condition of the tree growth, the latter to the abundance of epiphytic vegetation. The influence of strong winds on the arborescent vegetation on the rim of the crater and on the main ridges leading to it is especially well marked. Here, under these conditions of exposure, the vegetation receives the full effect both of the northeast monsoon blowing across Manila Bay and of the southwest one from the China Sea. A more detailed account of the effect of these winds will be given after the vegetation of the mountain top has been considered.

The fact that the relative humidity is higher in this situation, is made evident by the frequent fogs which at night, as a general rule, hang over the top of the mountain. The following readings, taken on clear days, were made simultaneously at Station 3 and at various altitudes on the main ridge:

Table XXI.—*Relative humidity at different altitudes on Mount Mariveles.*

1905.	Hour.	Altitude.			
		640 meters.	914 meters.	1,066 meters.	1,250 meters.
Mar. 23	9.00 a. m.	91	98		
	12.30 p. m.	77			
Mar. 24	7.30 a. m.	81	80		
	12.30 p. m.	75	85		
Mar. 29	8.30 a. m.	77	82		
	3.10 p. m.	52	54		
Mar. 31	8.00 a. m.	75	82		
	3.00 p. m.	62	60		
Apr. 5	8.20 a. m.	74		81	
	9.20 a. m.	75			89
Apr. 6	2.30 p. m.			76	
	1.30 p. m.	91			
Apr. 7	9.00 a. m.	77		78	
	10 00 a. m.	76		85	
Apr. 21	8.30 a. m.	94		82	
	9.30 a. m.	86			83
Average of 8 readings		78.8	77.6		
Average of 5 readings		82.4		80.4	
Average of 2 readings		80.5			86

These readings, although few in number, clearly indicate a higher relative humidity for the altitudes above 900 meters. This bears out the observations which have repeatedly been made that the stations above 900 meters were often in mist, whereas those below were not. The following temperature readings were made simultaneously at different altitudes:

TABLE XXII.—*Temperature at different altitudes on Mount Mariveles.*

1905.	Hour.	Altitude.			
		640 meters.	914 meters.	1,066 meters.	1,250 meters.
Mar. 23	9.00 a. m.	21.2	19.2		
	12.30 p. m.	24.2	21.4		
Mar. 24	7.30 a. m.	20.2	18.5		
	12.30 p. m.	24.8	20.6		
Mar. 29	8.30 a. m.	23.8	21.4		
	3.10 p. m.	26.5	25.5		
Mar. 31	8.00 a. m.	24.5	21.5		
	3.00 p. m.	26.5	25.4		
Apr. 5	8.20 a. m.	23		20.2	
	9.20 a. m.	23.2			19.6
Apr. 6	1.30 p. m.	21.5		21.6	
	2.30 p. m.				
Apr. 7	9.00 a. m.	24		20.6	
	10.00 a. m.	25		21.4	
Apr. 21	8.30 a. m.	23.5		21.5	
	9.30 a. m.	24.5			21.5
Average of 8 readings		24	21.7		
Average of 5 readings		23.4		21.1	
Average of 2 readings		23.8			20.5

Unfortunately, no readings were obtained for the early morning hours during January or February, so that the minimum temperature on the mountain can not be ascertained. The lowest reading for February at Station 3 (640 meters) is 17°.8 C. The greatest difference in temperature observed between the station at 640 and that at 1,250 meters is 3°.6. If this same ratio had obtained when the reading 17°.8 C. was taken at the 640-meter station, then the temperature would have been 14°.2 C. at 1,250 meters. To judge from the above calculation it is probable that the temperature of the top of the mountain does not fall much, if any, below 14°, and it should be noted that this is far above the danger point for tropical plants, because Molisch [47] has shown that members of the *Gesneriaceæ*, which belong in this class, died only when a temperature of between 2°.5 C. and 4°.4 C. was reached. The margin between 14° C. and 4°.4 C. is certainly a wide one and even though it be true that the temperature on the top of the mountain *may* fall below 14° while the minimum for the existence of tropical

[47] Molisch, H.: Das Erfrieren von Pflanzen bei Temperaturen über dem Eispunkt, *Sitzungber. Akad. Wiss.*, Vienna (1896), **105**, part 1, 82 to 95.

plants is higher than 4°.4 C., yet it is not probable that the plants of the lowlands are excluded from the top because of low temperature alone.

The topography.—The topography is such as to offer no very stable place for vegetation to gain a foothold. It consists of the knife-like ridges, which seem to be characteristic of tropical, volcanic mountains in a youthful stage of erosion, and precipitous slopes leading to the principal streams which lie at the bottom of the cañons separating these slopes. The latter, in turn, are cut up into steep ridges and side cañons, the inclination of both of which in places may be very precipitous. The side cañons such as are found near the headwaters of the Lamao River, during the rainy season, present waterfalls and cascades, and the side ridges usually end in the precipitous walls of the Lamao River canyon. (Pls. I and II.)

In contrast with the topography of lower altitudes, that of the top of the mountain presents narrower main ridges and steeper side ridges and canyons.

The ridge vegetation.—Eight plots were made, each one corresponding to a definite physiographic outline on the main south ridge leading from a peak ridge at 900 meters' altitude to Buena Vista peak (altitude 1,266 meters) on the rim of the crater, a distance of about 6 kilometers. These plots were undertaken with the purpose of determining the nature of the vegetation in this situation and of discovering, if possible, what factors, climatic and edaphic, determine the differences.

Description of Table XXIII.

A is a plot approximately 8 by 45 meters at 900 meters extending through an altitudinal range of 3 to 4 meters. It is an exposed peak, with soil composed of clay, some loose rock, and a half-disintegrated outcrop of volcanic rock. B is a plot 6 by 37.5 meters at 900 meters' altitude on top of a hard, volcanic rock with little soil. It is an exposed peak. C is a plot 5 by 30 meters at 914 meters' altitude on a level ridge, not as exposed as A or B. The soil is a heavy clay, with some loose rock, although it presents no outcrop. Plot D is irregular in shape, comprising about 175 square meters on an exposed cliff which shows a volcanic outcrop of rock, with a little shallow soil in places (altitude 1,034 meters). Plot E has an area of 7 by 45 meters on a level stretch, at 1,034 meters in altitude. The soil is composed of deep clay, with large bowlders which have withstood weathering processes. F is a plot of 4 by 48 meters, on a bluff similar to that of Plot D, but with slightly more soil (altitude 1,100 meters). G is a plot of 4 by 50 meters at an altitude of 1,135 meters on a level ridge which has a fair amount of clay soil, although semidisintegrated rock is near the surface. Plot H with an area of 5 by 35 meters is at an altitude of 1,265 meters (Buena Vista peak). The soil characteristics are similar to these encountered in Plot A, but the exposure is greater. I is the total of each species in all plots; J, the percentage of each species in all plots. No trees under 3 meters are included and none reached a height of over 15 meters.

TABLE XXIII.

Name of plant.	A.	B.	C.	D.	E.	F.	G.	H.	I.	J.
1. Eugenia congesta				1	5	3	30	25	64	9.18
2. Eugenia acuminatissima	32	4	17	4					57	7.16
3. Acronychia laurifolia		12		29					41	5.87
4. Quercus sp	14		2	3	6	6	7	2	40	5.73
5. Vaccinium cumingianum				15	1	7	4	6	33	4.73
6. Clethra lancifolia					6	9	8	5	28	4.01
7. Vaccinium jagori						10	4	14	28	4.01
8. Leptospermum amboinense				11		8		5	24	3.44
9. Myrica rubra	7				1	8	4	3	23	3.29
10. Symplocos confusa						2	9	11	22	3.15
11. Photinia luzonensis				5		5	1	8	19	2.72
12. Decaspermum blancoi		16							16	2.29
13. Decaspermum paniculatum		4		9		3			16	2.29
14. Sideroxylon angustifolium				3	8	1	4		16	2.29
15. Ternstroemia toquian	4		10		2				16	2.29
16. Alstonia parvifolia				7		5	1		13	1.86
17. Eurya acuminata				4	1	4		3	12	1.72
18. Ligustrum cumingianum		6		5					11	1.58
19. Linociera coriacea	11								11	1.58
20. Polyosma philippinensis	1		4		4			2	11	1.58
21. Adinandra luzonica							10		10	1.43
22. Buchanania florida	5	5							10	1.43
23. Evodia retusa						5	5		10	1.43
24. Helicia philippinensis				10					10	1.43
25. Casearia crenata		3		6					9	1.29
26. Excoecaria philippinensis	9								9	1.29
27. Scolopia crenata	1	8							9	1.29
28. Astronia rolfei	1				4		3		8	1.15
29. Agathis philippinensis	1		4	1		1			7	1.00
30. Englehardtia subsimplicifolia	1			2		1	3		7	1.00
31. Eriobotrya ambigua		1		5	1				7	1.00
32. Helicia cumingiana					4		3		7	1.00
33. Leucosyke capitellata var. celtidifolia		7							7	1.00

TABLE XXIII—Continued.

Name of plant.	A.	B.	C.	D.	E.	F.	G.	H.	I.	J.
34. Antidesma sp	6								6	0.86
35. Machilus philippinensis	2	1	1		2				6	.86
36. Eugenia sp			1		4				5	.72
37. Ficus sp	3		1		1				5	.72
38. Glochidion sp				1	1	2		1	5	.72
39. Allophylus sp		4							4	.57
40. Canarium villosum	2	1	1						4	.57
41. Pithecolobium prainii						4			4	.57
42. Symplocos ahernii			1	2			1		4	.57
43. Viburnum odoratissimum	4								4	.57
44. Weinmannia luzoniensis						3		1	4	.57
45. Ficus bataanensis				1	1	1			3	.43
46. Linociera luzonica					3				3	.43
47. Mastixia pentandra			1	1	1				3	.43
48. Calophyllum whitfordii			1					1	2	.29
49. Gynotrochis parvifolia					2				2	.29
50. Talauma villariana				2					2	.29
51. Sp. indet						2			2	.29
52. Cryptocarya luzoniensis					1				1	.14
53. Eugenia robertii			1						1	.14
54. Ficus sp	1								1	.14
55. Fagraea obovata		1							1	.14
56. Linociera luzonica		1							1	.14
57. Murraya exotica				1					1	.14
58. Nauclea purpurea			1						1	.14
59. Palaquium sp					1				1	.14
60. Plectronia viridis	1								1	.14
61. Rubiaceae sp				1					1	.14
62. Sterculia montana		1							1	.14
63. Symplocos ferruginea	1								1	.14
64. Mischocarpus triqueter	1								1	.14
65. Vernonia arborea								1	1	.14
Total	108	75	46	129	60	90	97	88	693	100.00

Some striking contrasts and resemblances are shown in a comparison of these plots. Of the 21 species found in Plot A (see Pl. XXXIV) and the 15 found in Plot H (see Pl. I), only 3 are common to both; one of these, *Polyosma philippinensis,* is represented by 3 individuals; the second, *Myrica rubra,* by 10 individuals, and the third, *Quercus,* by 14 in A and 2 in H; however, this latter may represent two species. To what then is this difference in vegetation due? It can not alone, if at all, be ascribed to a lower temperature, for this factor is but a small one. The depth and character of the soil are approximately the same, for both plots have shallow soil composed principally of half-disintegrated volcanic rock. Precipitous slopes on each of the sides of the ridges characterize both situations. The difference can not then be due to the water-holding capacity of the soil, for if anything, as will be shown presently, the soil in the higher situation has more water than that in the lower, yet the tree vegetation in the former is more xerophytic than in the latter—that is, the trees are more stunted and the leaves are harder, smaller, and more leathery. This point is clearly demonstrated in the species common to both situations; the oaks invariably have smaller and harder leaves; a specimen of *Calophyllum whitfordii,* collected from a stunted tree near Plot A, at first gave rise to the belief that this was a species distinct from that found at lower and more protected altitudes in the *Shorea-Plectronia* formation; but when fertile specimens were collected in Plot H from a still more stunted tree and with still more reduced and hardened leaves, the series was complete, extending from the comparatively mesophytic leaves taken from tall trees in the *Shorea-Plectronia* formation, through the less mesophytic forms found near Plot A, to the xerophytic leaves of that found on H. (See Pls. XLIII, XLIV, XLV.) The same may be said of other species, such as *Myrica rubra,* common to the three situations. (See Pl. XLIV.) These gradations can be extended so as to include many species not common to the two plots under consideration, but found in different ecological conditions from the base to the summit of the mountain and which systematists are tempted to, and often do, separate as distinct species, if ecological gradations between the two extremes are not in their possession. (See Pls. XLIII, XLIV, XLV.) These cases only illustrate the fact which has been so often emphasized for plants occurring in the temperate zone, that species capable of sufficient plasticity can adapt themselves to conditions in such a manner as to grow in various ecological situations. But few have this power of wide life-range, and so it happens that different ecological aspects show different species, rather than different forms of the same one. This latter fact is strikingly illustrated by the largest number of individuals on the ridge under consideration. (See Pl. XLV.) *Eugenia congesta* found in the upper five plots has orbicular, very leathery leaves, while *Eugenia acuminatissima,* in the lower four plots, has small,

narrow ones of less xerophytic structure. Only in Plot D does the distribution of these species overlap. Other trees with very xerophytic leaves, found in the upper plots and not represented in the lower ones, are *Vaccinium jagori, V. cumingianum, Leptospermum amboinense,* and *Clethra lancifolia,* all low, scraggy trees with leaves very suggestive of those of the *heath* family to which two of them belong. Indeed, ecologically the forest of the ridge very much resembles the *heath* associations, so common in dry, sandy soils or exposed windy places of the north temperate zone, except that here the plants are trees rather than shrubs.

There is a striking difference in the relative humidity of the two situations. (See Table XXI.) Many visits to Plot A, when the weather was clear at this locality, showed Plot H to be bathed in dense fog. Often, an early morning journey from Station 3 to the top of the mountain demonstrated Plots A and D to be dry while above Plot D the vegetation would gradually become more and more wet, until near Plot H it would be reeking with moisture. While this relative humidity in itself tends to reduce the transpiration of the foliage of the trees and to conserve the moisture of the soil, so as to render more water available for absorption and thus to produce a less xerophytic condition, yet it is seen that the tree vegetation is more, rather than less, xerophytic. If, then, soil, moisture, and atmospheric humidity can not explain the ecological difference in the habitat for arboreal vegetation of the two places, then it must be due to the greater influence of the wind in the two situations. As one ascends the mountain, this becomes more and more pronounced, the trunks of trees become shorter (see Pl. XXXIV), until in many places near the top of the highest peaks the trail becomes a tunnel the top of which, composed of mingling branches of the trees, is so low that one often has to stoop in order to pass through it. The branches, also, in many cases, become more scraggy and crooked and the twigs shorter and stouter. Again, especially in the case of *Leptospermum amboinense* (see Pl. I), the branches have an arrangement in one or more stiff, horizontal planes and known as the umbrella type, which, according to Schimper,[48] is an adaptation calculated to resist the strong winds. This tree is invariably found on the most exposed places, where the erosion is sufficiently rapid to keep the bed rock at or near the surface. Its leaves are so reduced in size and so hard as to become almost like coniferous ones in form and texture. On the whole, the effect of exposure on the arboreal vegetation on the ridge under consideration is such as to obtain here, so far as stunted growth and reduction in leaf size is concerned, the most xerophytic condition on the Reserve, not excepting the extremely xerophytic vegetation of the sea beach cliffs and the mangrove swamps, and this condition is brought about notwithstanding the fact

[48] Schimper, A. F. W.: *Pflanzengeographie auf physiologischer Grundlage* (1898), English edition, translated by Fischer (1903), 348.

that, on the whole, the relative humidity and the rainfall are greater and the average temperature is lower, all factors which are favorable to mesophytic vegetation.

In the above discussion, two areas presenting approximately the same soil conditions have been compared. It now is in order to discuss situations in which the altitude and exposure are the same, but in which the soil conditions differ. In this respect Plots A and B offer admirable examples. The former has already been described. Plot B is separated from it by a ridge-saddle only. It is a large rock (Pl. XXXV) on three sides standing 4 to 6 meters above the ridge on which it is situated, on the fourth grading more perceptibly into the ridge itself, although here also it rises slightly above it. The upper surface is covered with a very thin soil most of which owes its origin to vegetable decay. On this rock the arboreal vegetation has established itself only because its fissures offer opportunity for the former to maintain a foothold. Both the dwarfed condition and leaf surface of the trees which are present show this situation to be a more xerophytic one than that of Plot A. The species are almost entirely different. *Eugenia acuminatissima,* represented by 32 individuals on Plot A, here has only four and these are at the end of the rock where the soil is deepest. *Acronychia laurifolia, Decaspermum blancoi, D. paniculatum, Ligustrum cumingianum, Leucosyke capitellata* var. *celtidifolia,* found in Plot B, are not represented in Plot A, although nearly all of them occupy places in a similar situation in Plot D, which is on a rock cliff distant some 2 kilometers, at an altitude 150 meters higher. *Acronychia laurifolia* and *Decasperum paniculatum* are good illustrations of the deciduous habit in trees on the mountain and emphasize the xerophytic nature of the ridge habitat. Both these trees, like the other species, have hard, xerophytic leaves. During the latter portion of March and first part of April they are almost destitute of foliage. The leaves of *Acronychia,* before they are shed, fold or half shut on the midrib, thus considerably reducing the transpiring surface. Many other trees also show a more diminished leaf display during a portion of the dry season than they do during the rainy one. Indeed, almost without exception, as is true of the formation at the base and in more xerophytic situations on the higher slopes, there is an interval of time between the beginning of the shedding of the old leaves and the appearance of the new ones. This, in the aggregate, makes the forest canopy much thinner during the dry months and is undoubtedly an adaptation to prevent rapid transpiration.

On ascending from the slopes of the *Shorea-Plectronia* formation to the first prominent ridge peaks, one finds a very sudden transformation from the tall trees to the dwarfish arboreal growth of the ridge (see Pl. XXXIV and contrast it with Pl. XXII), and apparently in conformity with this change there is a still greater variation in the multiplicity of the species and the individuals of the epiphytic vegetation. This

change appears to be remarkably abrupt, because the lower trees render the plants more visible to the casual observer, but in reality it is not so great as at first it would seem to be. It has already been noted that toward the upper limits of and in more favorable situations in the *Shorea-Plectronia* formation, there is a tolerably rich display of epiphytes, which in the more closed places of the forest are confined to the large limbs of the tallest trees, because the shade of the latter is so dense as to exclude plants accustomed to places having more light. However, as the higher and more exposed altitudes are reached and trees become lower, epiphytic vegetation, represented by mosses, a few liverworts, and an occasional orchid or fern, is found not only on the limbs but also on the trunks of the trees, so that, advancing from Plots A to H there is a gradual increase in richness of the epiphytes. This increase is in direct correspondence with the rise in the humidity. As has already been mentioned, the region near the top of the mountain is more often enveloped in a dense fog than are the other parts and to this difference in humidity the wealth of epiphytes can be ascribed. It is a well-known fact that plants, especially orchids, which depend on the moisture of the atmosphere for the water which they absorb, are not capable of condensing the vapor present therein but on the contrary, must have condensed water for their needs—that is, the moisture must be accessible to them in the form of rain or mist. In plants with absorbing organs adapted to take up moisture from the air, and exposed alternatingly to a very moist and a very dry atmosphere, xerophytic adaptations are necessary.

For the purposes of this paper, the epiphytic vegetation of Mount Mariveles may be divided into three groups, viz, (1) plants with xerophytic, photosynthetic organs and special adaptation for absorbing moisture; (2) those with mesophytic leaves which, by assuming the so-called resurrection form, can withstand loss of moisture and (3) the forms with xerophytic leaves and with no special adaptations for absorbing moisture. The lichens and orchids belong to the first group, and these are classed together because the velamen of the orchid roots, in times of drought and excessive moisture, behaves in the same manner as does the fungus element of lichens. On the trunks of the trees situated at the mountain top but few lichens are found, because these more favorable situations are quickly occupied by other less humble epiphytes; as a result the lichens are confined to the faces of newly broken rocks whereas the older ones are as densely covered with mosses, liverworts, and ferns as are the trunks of the trees.[49] The trees of the lower altitudes, with trunks the bark of which is smooth and not frequently shed, are often so thickly covered with crustaceous species of lichens as to render it almost out of the

[49] Strictly speaking, of course plants growing on rocks are lithophytes. Ecologically they are like epiphytes and are here classified as such.

question to determine the original color of the bark. A number of gray *Cladonia* and *Usnea*-like lichens are found on the branches of the trees growing at higher altitudes, intermingled with the greener mosses and liverworts. These may be seen hanging in festoons or as upright, fruticose forms. However, in this situation the lichen vegetation is comparatively insignificant. The orchid epiphytes, on the other hand, are very rich in species and some of the latter are represented by many individuals. Varied forms are exhibited. The most common one encountered above the 1,000-meter line is the grass-like *Acoridium tenellum* (see Pl. XXXVI) and other species of *Acoridium* simulate the latter but not so successfully. Species having exceedingly fleshy leaves are very abundant, some forms with and some without their leaf bases swollen into bulbs; others have creeping rootstalks embedded in the other epiphytic vegetation. When this is the case, the velamen may be poorly developed or be wanting altogether. Most humble is the small *Taeniophyllum obtusum*, with no leaves at all but with roots which act as photosynthetic organs. In this respect the arrangement of its chlorophyll and protective (velamen) tissue is exactly like that in the fruticose lichens, excepting that the side of the root next the substratum has no chlorophyll. Some idea of the richness of the orchids in species can be given by the following list: *Corysanthes merrilli, Coelogyne sparsa, Pholidata imbricata, Platyclinis glumacea, P. latifolia, Acoridium tenellum, A. whitfordii, Cestichis philippinensis, C. merrilli, C. compressa, Ceratostylis philippinensis, Dendrobium macraei, Eria graciliscaposa, Phreatia luzonienses, Bulbophyllum bataanensis, B. cuneatum, B. dasypetalum, B. lasioglossum, B. whitfordii*, and a large number of species not yet determined. (See Pls. XXXVII and XXXVIII.) The fact that, so far as the ridge is concerned, there is scarcely a full-grown tree to be found above the altitude of 1,000 meters which has not twenty or more specimens on it, will show the abundance of individuals.

The second group of epiphytes is represented by mosses, leafy liverworts, and the so-called "filmy" ferns (*Trichomanes* and *Hymenophyllum*). All of these are plants having very delicate, mesophytic leaves which, because of their texture, have the capacity of directly absorbing moisture, and which, during the hotter and drier parts of the day, lose water to such an extent as to wither and curl up. (See Pl. XXXVIII.) They remain in this condition until the relative humidity of the atmosphere increases to a sufficient extent to enable them to recover their rigidity. These "resurrection" plants increase in abundance of species and individuals with the rise in the frequency of fog and relative humidity. Strictly speaking, the plants last mentioned, like the orchids, can not be classed as epiphytes alone, for they may grow on old logs and rocks. At the base of the mountain, comparatively speaking, there is a poor expression of moss, fern, and liverwort vegetation. Here they either occupy positions at the bases of the trees,

as is the case with the moss *Taxithelium instratum,* or on bowlders in the streams where the mosses *Fissidens zollingeri, F. zippelianus,* and *Ectropothecium* and others are found. In the low altitudes, filmy ferns of the genus *Trichomanes* are encountered only on shady, damp rocks at the edges of the streams; however, as one ascends their beds, the rocks become more and more covered with mosses; but in such situations, because of the swift currents in times of high water, the type is poorly represented. On the whole, the infrequency of these plants in the lowlands and indeed below the *Eugenia-Vaccinium* formation, is a noteworthy fact and is in direct response to the dry conditions during a portion of the year which favor what for convenience may be called *annual* rather than *daily* tropophytes. In the ridge under consideration, and below 1,000 meters, the filmy fern vegetation is scanty and it appears only in the shade; above this altitude it becomes abundant and it then increases with the elevation, however being always more abundant in the shady rather than in the sunny spots. *Hymenophyllum multifidum, H. smithii, Trichomanes pallidum, T. bipunctatum,* and others are among the species present. (See Pl. XXXVIII.) On the other hand, the liverworts and mosses are prominent features between Plots A and D, although they are much more so from F to H. Indeed, in these latter places, trees are covered with these plants from the bases of their trunks to the ends of their twigs, where the leaves are usually grouped. On rocks, fallen trees or limbs, and in every place in the shade where the wash from the heavy rains does not prevent their occurrence, dense masses, which give such an aspect to the vegetation called the "mossy forest," accumulate. Plates XXXVI, XXXVII, and XXXVIII show the richness of this forest in these epiphytes, and the list of mosses and liverworts given below indicate the number of species which occur although, no doubt, only a small percentage of the total number has been collected: *Hepaticeæ: Brazzania erosa, B. praerupta, Lepidoza trichodes, Mastigophora diclados, Schistochila aligera, Frullania integristipula,* and *F. orientalis. Musci: Dicranoloma blumei. Leucobryum sanctum, L. javense, L. angustifolium, Macromitrium cuspidatum, M. reinwardtii, Rhizogonium spiniforme, Spiridens reinwardtii, Aerobryum lanosum,* and *Sematophyllum altopungens.*

The third group of epiphytes is largely composed of ferns.[50] Many of these are facultative epiphytes and frequently the moss and liverworts furnish a substratum for them. Since this substratum is alternately dry and wet, the response to the severe conditions is found in their

[50] Dr. E. B. Copeland, who is writing on the comparative ecology of the Philippine ferns, informs me that epiphytic ferns which are not embedded in moss usually have their roots covered with a felty mass of persistent root hairs, and that these are often absent when the roots are so embedded. Such ferns would then have special absorptive organs and would be classified with the orchids and liverworts.

xerophytic, sometimes partially tropophytic, leaves. *Humata repens* (see Pl. XXXVIII) is probably most common. It has a small, creeping rhizome, usually buried in the bed of moss and other plants with which it grows. *Polypodium glaucum, P. palmatum, P. triquetum, P. accendens,* and others are similar to it in habit. *Davallia solida* and *Oleandra colubrina* also have this creeping habit. The latter has connection with the ground, and it sometimes reaches the tops of stunted trees; its mottled, snake-like stem often not being buried in the living substratum. Prominent because of its size and abundance, is the bird's-nest fern, *Asplenium nidus.* (Pl. XXXIX.) It usually starts in a crotch of a tree, where some vegetable débris has already accumulated; or in a knot hole, in which case it may encircle the entire trunk if the latter is not too large; once established, the "nest" part of the fern accumulates an amount of soil sufficient to bury its roots. The substratum so provided furnishes a favorable habitat for other ferns, so that scarcely a specimen of the bird's-nest fern was noted which did not also have present the long, pendant fronds of *Polypodium subauriculatum.* The strap-like leaves of *Ophioglossum pendulum* are present with much less frequency. The living substratum, together with the accumulated decaying vegetable matter and inorganic débris may in places be so dense that shrubs like *Rhododendron quadrasianium* and *Medinilla ramiflora* may start and live throughout their entire existence on the branches of trees. Seedlings of trees such as *Eugenia congesta* may also be present on branches of their own kind. (See Pl. XXXIX.) The bulbous base of the ant fern, *Lecanopteris carnosa,* besides harboring insects, acts as a storehouse for moisture.

The vegetation, other than that of trees and epiphytes, also varies with the plot, but those plots which are alike in physiography and atmospheric moisture show a remarkable similarity. In situations which are too poor or unstable to support tree vegetation, and which are not shaded by overhanging cliffs, the grasses *Garnotia stricta* and *Miscanthus japonicus* and the sedge *Carex continua* predominate. This is the case in places in or near plots B, D, F, and H. Terrestrial ferns are represented by a large number of individuals during the wet but are less noticeable during a portion of the dry season. Among these may be mentioned *Dipteris conjugata* which, in open places at the head of land slips, forms colonies very much resembling those of the may-apple (*Podophyllum peltatum*) so common in the eastern part of the United States. In similar situations also thickets, 1 to 2 meters in height, of *Dicranopteris* occur. On the ridge, dwarf specimens of the tree fern *Cyathea caudata* are scattered, and just below the top of the rim of the crater are a few individuals of *Marattia sambucina.*

The herbaceous seed plants which are partly or wholly wanting during a portion of the dry season are *Coleus multiflorus, Scutellaria luzonica,* an unknown saprophytic orchid, and very rarely *Arisaema polyphylla.*

Less herbaceous and with a portion of the leaves persistent is *Desmodium polycarpum ovalifolia.* Near the top especially on the slopes barely sufficiently stable to hold soil, are dense groves of the suffrutescent acanthaceous *Strobilanthus merrillii* and *S. pluriformis* with prop roots. These species have mesophytic leaves which are shed for a short time at least; the small green bracts of the inflorescence stalks, however, remain persistent and perform the function of the leaves. Among the erect and scandent shrubs are the following: *Chloranthus brachystachys, Discocalyx cybianthoides, Neslitsea zeylanica, Melastoma fusca, Memecylon affine, Medinella ramiflora, Pittosporum odoratum, Pandanus whitfordii, Thea montana, Viburnum sinuatum, Wickstroemia lanceolata, W. ovata,* and the following rubiaceous species: *Heydotis elmeri, Urophyllum bataanense, U. acuminatum, Psychotria bataanensis, P. diffusa, P. rubiginosa, Lasianthus bordenii, L. obliquinervis,* and *Amaracarpus pubescens.* It will be seen from the above list that the *Melastomaceæ* and *Rubiaceæ* are well represented in number of species. Two small palms, *Pinanga elmerii* and *P. barnesii* are found on the slopes, just beneath the top of the ridge, the former near all the plots and the latter at the higher altitudes. The liana vegetation is best represented by *Freycinetia ensifolia* which is on nearly every tree in the closed, mossy forests; *F. luzonica* is less frequently encountered. *Hiptage luzonica, Strongylodon macrobotrys, Dinochloa tjankorreh,* and a number of species of *Calamus* may be mentioned among the lianas. Shrubs and vines with showy flowers are represented by members of the *Melastomaceæ; Melastoma fusca* (shrub) and *Medinella coriacea* (vine) are present and their large, red flowers add color to the vegetation. The large, white, sweet-scented flowers of *Rhododendron vidalii* and *R. schadenbergii* appear profusely near the 1,100-meter contour line.

The pitcher plant, *Nepenthes alata,* is found in open places in this altitude and above. The sharp, knife-like rim of the crater (Pl. I) between Buenavista and Cabcaben peaks shows dense tangles of this plant, growing intermingled with shrubs and vines with here and there isolated patches of *Dicranopteris* and an occasional *Marattia.* Specimens of the *Schefflera blancoi* and *Pittosporum resiniferum* have the *balete* habit in capturing and strangling trees, although the latter from the beginning is a true liana and does not start as an epiphyte, as does the former. The upper portions of the main ridges leading to Cabcaben peak (outside the Reserve) and to Caybubo peak show conditions approximating the ones just described.

The vegetation of the slopes.—The slopes on either side of the Lamao River cañon (Pl. II) show some resemblances to and many differences from the ridge vegetation. The vegetation on the overhanging cliffs at the ends of the slopes leading to the canyons have much in unison with plots like D; for instance, the grass *Miscanthus japonicus* is common in this situation and the shrubby species of *Pittosporum odoratum* and *Acrony-*

chia laurifolia also predominate. The side ridges, as a general rule, consist of a series of short, steep inclines with talus slopes at their bases. The tree vegetation of the slopes consists of the taller and less xerophytic trees of the ridge, together with other species which probably are not able to exist on the more exposed places. Near these ridges the tree tops are covered with epiphytes, but these become much less common nearer the river bed, where the fog is less dense. In one plot the following trees were noted as being common: *Eugenia congesta, Eurya acuminata euprista, Adinandra luzonica, Eugenia acuminatissima, Thea montana,* and *Clethra lancifolia;* these are intermingled with *Pygeum latifolium, Palaquium whitfordii, Eugenia bataanensis, Eugenia robertii, Agathis philippinensis, Semecarpus* sp., and others. In one place, nearly 75 per cent of the stand is the myrtaceous *Tristira decorticata.* This species is also common on and near the top of Limay peak, the vegetation of which is comparable with that of the side ridges of the Lamao River, having the same altitude, but the extreme summit of this peak itself has only a stunted growth. However, while the side ridges present a more mesophytic vegetation, as is evidenced by less stunted trees and the xerophytic leaves, the vegetation in this situation, owing to the unstable conditions, does not reach the luxuriance and the size which it would be expected to have as a result of the climate. It is perhaps because of this instability, that more fallen trees were noted in this region than on any other portion of mountain, although it is one of the surprising features of tropical mountain vegetation that very precipitous slopes, having a grade of from 45° to 60°, often are covered with a closed forest. Inclines of over 60° so often crumble that few trees have a chance to gain anything more than a temporary foothold thereon.

The side ravines near the headwaters of the Lamao River are very unstable. Where signs of ground water near the surface are in evidence, species of mosses, liverworts, and ferns are present in such situations, although the variety and the number of the individuals are much less than they are on the ridges. The very large-leaved fern *Dennstaedtia smithii* and the tree fern *Alsophila contaminans* are encountered here, the latter in the Lamao River cañon itself reaching to a height of 8 or 9 meters.

Cirque-like basins which are comparatively stable appear in many places near the upper ends of the side ravines. Groves of *Pandanus arayatensis* are encountered in these situations and here also the tree fern *Cyathea caudata* reaches its largest size, being from 2 to 3 meters in height, the large, *Lycopodium*-like moss, *Spiridens reinwardtii,* usually growing upon it. The undergrowth is characterized by rubiaceous species and *Hydrangea lobbii.* The inside slopes of the crater are even more unstable than are those of the Lamao River cañon. Land slips are numerous, and comparatively, these sides show but a thin stand; yet when looked at from above, the closed forest seems to prevail. This is due to the fact that the foliage of the trees on either side nearly meet over the

narrow rocky gulleys and ravines. However, nearly perpendicular "scars" show a scanty growth of grass and of light-loving ferns. The vegetation on a "burn" at the head of one of these slides is worthy of mention because it shows the presence of a dense mat of *Funaria clavescens,* a species closely related to the *Funaria* which occupies similar situations in parts of the United States, and here, strangely enough, the cosmopolitan *Pteridium aquilinum* is also present. After a "slide" has occurred, the vegetal reclamation is rapid. In many places *Funaria calvescens* is the pioneer. The grasses *Miscanthus japonicus, Garnotia stricta,* the sedges *Hypolytrum latifolium* and *Carex continua,* and the ferns *Pteris tripartata* and *Pteridium aquilinum* are among the other species which may be mentioned as establishing an early foothold. These may be closely followed by acanthaceous and rubiaceous shrubs. In one place, *Rubus moluccanus, R. rosaefolius,* and *R. tagallus* were noted, while in addition, scattered specimens of the euphorbiaceous trees *Macaranga cumingii* and *Homalanthus populneus* are usually present, *Melastoma fusca* being also an early comer. As the stability of the slide increases, the composition finally partakes of the nature of the vegetation which is nearest to it.

Summary.—1. The *Eugenia-Vaccinium* formation may be divided into two parts; the exposed ridges and their less exposed, unstable slopes.

2. The ridge vegetation is characterized by stunted trees, due to the influence of the wind, and by its richness in epiphytes, caused by the frequency of fogs.

3. The vegetation of the ridge is strongly suggestive of the "heaths" of the north temperate zone, excepting that heath-like trees replace the shrubby growth of the latter region; and orchids, filmy ferns, and liverworts are found in addition to the lichens and mosses.

4. The instability of the slopes prevents the best possible development of the vegetation which the climate (exclusive of wind) might support.

5. At the same altitude, different physiographic situations show a marked difference in the ecological character of the vegetation.

VI. Strand Formations.

The vegetation of the strand has been divided into two distinct types; that of the sandy seacoast lying above high tide, and that of the muddy shore situated between low and high tide. These two types, which are often adjacent, have an ecological similarity, but floristically they show a decided difference. Our knowledge of the composition and of the ecological adaptations of the strand vegetation is due in the main to Schimper [51] and Karsten.[52]

[51] Schimper, A. F. W.: *Loc. cit.*, 387–411, also, Die indo-malayische Strandflora, *Bot-Mittgn. Trop.* (1891), 3.

[52] Karsten, G.: Ueber die Mangrove-Vegetation im Malayischen Archipelago, *Bib. Bot.* (1891), 22.

The 5 kilometers of coast line pertaining to the Lamao Reserve offers insufficient data for a true conception of the vegetation of the seashore of the Philippines, yet in this very situation a dilute expression of all the formations of the strand which have been made classic by the work of Schimper and others may be encountered. In order to render clear the genetic relations of these formations it is advisable to make use of data gathered outside of the area under consideration, and then to classify the stages in the development found at Lamao.

The material composing the beaches either is derived from rocky promontories or is washed into the sea by streams. If the shore current and waves are sufficiently strong to handle all this material then no accretion to the shore line takes place, but if, on the other hand, as is more often the case, the shore current can not bring this about, then an encroachment of the land on the sea results with a consequent development of new habitats for plants. If the shore current can not take care of the finer particles of the material eroded from cliffs or washed in by rivers, then obviously the heavier ones settle on the strand. Thus the size of the material composing the beach is determined by the power the current possesses of controlling the suspended matter carried by it, and, as a consequence, pebbly, sandy, or muddy shore lines may result. On some strands the very force which prevents the deposit of fine particles, excludes the growth of nearly all vegetation between the lines of low and high tide, so that, with the exception of scattered seaweeds, these places are destitute of vegetation. On the other hand, where the hydrodynamic conditions favor the deposit of materials lighter than sand, then they are also favorable for the establishment and growth of vegetation. In such places the characteristic formation not found anywhere outside of tropical countries is developed. Therefore, it will be seen that because of the physiographic forces at work along shores, two distinct habitats are established. Following Schimper, with some minor changes, the vegetation corresponding to these may be divided into—

1. Sandy beaches lying above high tide.
   - (*a*) *Pes-capræ* formation.
   - (*b*) *Barringtonia-Pandanus* formation.
2. Strand, lying below high tide.
   - (*a*) Mangrove and *Nipa* formations behind sandy beaches.
   - (*b*) Mangrove and *Nipa* formations not behind sandy beaches.
     - α. Formations at the mouths of rivers.
     - β. Formations at the base of cliffs.

1. SANDY BEACHES, ABOVE HIGH TIDE.

(*a*) *The Pes-capræ formation.*—The beach is built up most rapidly at the mouths of rivers. In the case of the Lamao River, for instance, two spits are at present being formed, one on each side; at high tide,

their distal ends are submerged and since the littoral current and waves are sufficiently strong, no vegetation has gained a foothold. However, at the proximal extremities, triangular patches of newly formed beaches above high tide exist, and thereon the best expression of the *Pes-capræ* formation can be observed.

The tropical cosmopolitan creeper, *Ipomoea pes-capræ,* is almost always present. This remarkable plant becomes established at a point lying a few meters landward from the upper limits of high tide, and it may, from a woody base, send out runners in all directions to a distance of as much as 10 meters; these latter take root and thus may become new centers; often their ends reach to the sea, whereupon the portion which is bathed by the salt water is killed back. This plant takes possession by runners and seedlings as rapidly as the beach is formed.

Other creepers found in this formation and having similar habitats are *Spinifex squarrosus* (the porcupine grass) and the legume, *Canavalia obtusifolia.* These plants, in addition to a few weeds, are practically the only ones to be observed on the strand at Lamao, although in similar physiographic situations in other parts of the Islands a greater diversity may be encountered.

The deposit away from the mouth of the river usually is formed with less rapidity, and, correspondingly, the *Pes-capræ zone* then is narrow or entirely absent, although in the older beaches in open places its elements may anywhere be found, excepting at the foot of the cliffs where it is usually wanting. Owing to the small size of the rivers of the Reserve, a rapid formation of the beach does not take place. In many parts of the Islands, where large streams flowing toward an open coast enter the sea, the triangular patches of the *Pes-capræ* formation become much larger, other plants, together with those mentioned, are then present and low dunes none of which, in these Islands, according to my observation, are over 2 meters in height are formed, on which the plants which have just been discussed act as sand binders.

(*b*) *The Barringtonia-Pandanus formation.*—On older portions of the beach, lying back of the *Pes-capræ* formation, or where this is absent fronting on the border of the sea, is the woody vegetation of the beach. This has been named by Schimper[53] the *Barringtonia* formation, from *Barringtonia speciosa.* On the Lamao strand this species is not present, although in similar situations it is common in other portions of the Islands.[54]

The most striking plant of the beach of the Lamao Reserve and in many other parts of the Philippines is *Pandanus tectorius,* and for this reason the formation has been given the above name. Together with

[53] *Loc. cit.,* 391.

[54] Much of the original vegetation of the beach at Lamao has been removed. This species may have been present.

Pandanus, Hibiscus tiliaceus, Erythina indica and *Terminalia catappa* are common. Less frequent are *Pongamia glabra, Thespesia populnea,* and *Heritiera littoralis.* Shrubs such as *Cerbera odollam, Morinda citrifolia,* and *Clerodendron inerme* occupy the edge or the more open places of the beach jungle. The scandent shrub *Quisqualis indica* and the semi-herbaceous vine *Wedelia biflora* are nearly always present. Near small villages, where the beach has been cleared, the introduced thorny *Prosopis julifora* has succeeded in gaining a foothold and in some places it is the only woody species present. Occurring with it, but less abundant, are *Pithecolobium dulce* and *Acacia farnesiana,* both exotics. *Calophyllum inophyllum* which, in some places, appears on the open sandy beaches is, for the Reserve, confined to a more protected shore line. The only specimen of the valuable timber tree *Intsia bijuga* (ipil) which has been observed on the Reserve, was noted in this situation. In clearings in the *Barringtonia-Pandanus* formation are *Ipomoea pescaprae, Canavalia obtusifolia, Spinifex squarrosus,* and the weeds, *Vernonia chinensis, Crotalaria retusa, Scoparia dulcis, Aerua lanata, Portulaca oleracea, Gynandropsis pentaphylla,* and *Datura fastuosa.*

More extensive observations of the vegetation of this formation outside the Reserve show that many plants enumerated by Schimper and others for the Indo-Malay region are also found in the Philippines, although a large number are not present in the limited area under consideration. (See map.)

Genetic relations.—As the beach grows, the plants of the *Barringtonia-Pandanus* formation advance into the *Pes-capræ* zone and eventually replace its vegetation, although the latter may still exist in artificial openings of the former. In the same way, the vegetation of the formation lying behind the beach in time occupies the older portions of the latter; thus, on the Reserve, the plants of the *Bambusa-Parkia* are present therein, although here the artificial conditions render this relationship confusing. Indeed, only the frontal zone of the beach shows a pure expression of the *Barringtonia-Pandanus* formation. As soon as this is penetrated, the character of the vegetation changes and relics of the former vegetative condition are then shown only by scattered individuals of *Pandanus* and the other species.

The beach habitat and the ecological characteristics of the vegetation thereon.—The beach is essentially a xerophytic habitat. This is shown by the stunted condition of trees, the umbrella habit of *Barringtonia speciosa* and *Terminalia catappa,* the fleshy leaves of the *Ipomoea, Canavalia* and others, and the hard, xerophytic leaves of all the tree species.

The factors of the beach habitat which bring about the xerophytic condition of the plants growing thereon are not definitely known. Probably a number of these are operative. Until lately it has been assumed that the plants of the strand and dunes are all halophytes. Investiga-

tions made by Kearney [55] show that the salt content of some sea beaches is indeed so low that he is justified in making the statement that so far as this factor is concerned, plants growing thereon are not halophytes. Walker [56] in studying this question in regard to the Philippine Islands finds only a trace of salt in the soil of the sea beach, and tests made of several specimens of sand from the Lamao strand confirm these results.[57] A surface soil, collected just at the upper limits of high tide, where runners of *Ipomoea* are present, shows 0.25 per cent of sodium chloride; one 6 meters back of this, where seedlings of *Erythrina indica* are abundant, gives only 0.004 per cent of salt; one 9 meters above high tide had a content of 0.005 per cent, and a sample just beneath the surface, 26 meters inland, gave 0.003 per cent. Ordinary, cultivated soil is known to contain from 0.02 to 0.2 per cent of sodium chloride. It is therefore out of the question to assume that the salinity of the strand has brought about the ecological adaptations for many beach plants.

On the other hand, salt spray is known to be deposited in considerable quantities on the leaves of trees growing near the beach. At any time of the year this can be detected by taste, and it is especially noticeable after a typhoon. It is a common observation that considerable quantities of this spray will injure and eventually kill delicate leaves of plants not accustomed to such habitats. During a prolonged typhoon in Manila, comparative observations were made on *Terminalia catappa,* the natural habitat of which is on the seacoast, and *Artocarpus incisa,* which has much more delicate leaves and the natural habitat of which is in more protected situations. The effect of the salt spray on *Terminalia* was hardly noticeable, while the whole of the seaward, and much of the landward, side of *Artocarpus* lost its leaves by a gradual withering, due to the effect of the salt spray. Therefore, leaves of trees growing on the frontal zone of the beaches must have characteristics which will enable them to withstand the physiological drying effect of sodium chloride. Coast lines are essentially windy places. Since no protection is offered to the vegetation, the frontal zone is constantly being exposed to the drying action of strong winds; in this respect it is comparable to the habitat of the ridge vegetation on the mountain and the likeness finds ecological expression in the stunted growth and the often "umbrella-like" shape of the trees.

The incapacity of the sandy soil to hold water is well known and tests of samples of sand from the Lamao beach, taken near the limits of high

[55] Kearney, T. H.: Are plants of sea beaches and dunes true halophytes? *Bot. Gaz.* (1904), **37**: 424–436. See this for literature of the subject.

[56] The coconut and its relation to production of coconut oil. Walker, H. S.: *Phil. Journ. Science* (1906), **1**: 59.

[57] Analyses made by L. A. Salinger of this Bureau. The percentages given are by weight of salt as compared with the air-dry weight of soil.

tide, showed this to be but 21.96 per cent. Reference to the table on page 426 will show this number to be less than one-half of that found for the clay soil of the interior. The sand which was tested had a humus content of 0.22 per cent, which is an exceedingly low figure; soils a few meters back of the situation from which these specimens were taken gave a considerably higher number, and consequently, their capacity to hold moisture is much better.

The sand of the Lamao beach shows a remarkably high percentage of magnetite; in one sample, taken from near the mouth of the river, 76 per cent of the total was composed of this mineral, although farther from the mouth, the percentage would probably be much less.

The effect of the dry season on the vegetation on the beach is marked. During this period, trees such as *Erythina indica* for a time shed their leaves and those of *Terminalia catappa* and *Barringtonia racemosa* redden and many of them drop before the new ones appear; the shoots of *Ipomoea* and other creepers partially or wholly die back and herbaceous weeds are nearly absent. Indeed, as a whole, during the season the thin appearance of the foliage is even more noticeable than it is in the *Bambusa-Parkia* formation. The vegetative activity, after the initiation of the rainy season, is as rapid as it is on the clay soil; runners of *Ipomoea* and *Canavalia* grow with amazing rapidity and seedlings of *Prosopis* and other introduced trees in a short time form thick stands. During this portion of the year both exotic and native plants, derived from many habitats which are much less xerophytic, do surprisingly well in the forest nursery which has been established on the beach. The underground water level of the beach, 30 meters back from the sea, is a little over 2 meters below the surface and at the base of the cliff landward from the sea it is much less. The roots of the trees of the *Barringtonia-Pandanus* formation which I have examined, in a number of instances reached to this level and so they have a constant supply of water upon which to draw. Once the seedling stage passed, no tree having a deeply penetrating root system would suffer from a lack of soil moisture on such a beach.

Another factor which is usually, and no doubt correctly, attributed as a cause promoting the xerophytic structure of beach plants, is strong light, because it increases the rate of transpiration. Copeland [58] has shown that in *Cocos nucifera* the change from a light haze to full illumination frequently multiplies the transpiration by four, and this is brought about by the fact that the leaf is heated above the temperature of the surrounding air. More light, and consequently more heat, reaches the leaves of plants on the beach than it does in the case of those situated in less sandy soils, because the reflection from the bright sand is greater

[58] Copeland, E. B.: On the water relations of the coconut palm, *Phil. Journ. Sci.* (1906), 1: 35–37.

than it would be from darker earth; it is also true that the vegetation overhanging the edge of the beach would have its transpiration increased by the increase in the temperature of the leaf because of the reflection from the water at high tide.

Schimper [59] calls attention to the fact that some beach plants are among the trees most commonly cultivated in the Tropics. My observation shows that not only is this true but also that many sea-beach plants are present in certain inland habitats and that in most instances such plants are more vigorous than individuals of the same species growing on the shore.

On the Reserve, isolated trees of such coastal species as *Erythrina indica* and *Pongamia glabra* grow in the forest along streams considerably above the influence of sea water and these trees growing inland are more vigorous than those growing on the coast. *Cycas circinalis*, a common plant of the coastal region in many parts of the Philippines, although not on the beach at Lamao, was collected from two localities at about 900 meters' altitude. A grove of these trees is situated near the top of Limay peak and the individuals there are more thrifty than any I have seen on the beach. *Ipomoea pes-caprœ* and *Spinifix squarrosus* are not confined to the strand, but also occupy positions beyond the influence of the sea. Outside the Reserve, the following trees grow both on the beach and inland: *Casuarina equisetifolia, Terminalia catappa,* and *Erythina indica. Terminalia, Erythina, Calophyllum inophyllum,* and *Barringtonia speciosa* are commonly cultivated in Manila and in other places in the Islands. In all instances the most thrifty trees are those not situated on the seashore. It is evident that where beach plants are propagated inland, they are more thrifty than individuals of the same species growing on the beach and that they can not be considered *xerophilous* in nature, though they are xerophytic. Ordinarily, the struggle for existence in the better soils is too great for them and hence they are driven to the coast, where their plasticity is such as to enable them to adapt themselves to the severe conditions imposed.

It is well known that most of the species common to the seashore have fruits adapted for disposal by water currents. The cosmopolitan nature of beach plants is to be attributed to this fact.

2. THE STRAND LYING BELOW HIGH TIDE.

As the detritus, washed into the sea by rivers reclaims land therefrom, bars may be formed and eventually these may be built above the level of the sea and in this way lagoons are eventually separated which, for a greater or less length of time are kept open by the ebb and flow of tides. Mud flats which often are not cut off from the open sea, are formed in protected bays or re-entrants, where deltas are in the process of building,

[59] *Loc. cit.*, 91.

but in these cases, owing to the fact that the breaker line is far distant from the shore, an area of more or less quiet water intervenes. Wave-cut terraces may be produced at the bases of sea cliffs, and these are often so covered with large boulders as to leave places between the latter fairly well protected from the heavy action of the waves, when the terrace is submerged at high tide. In a word, because of the absence of strong waves, the physiographic situations which have been discussed offer a favorable place for the establishment of plants. In the Tropics, these places are occupied by the well-known Mangrove and Nipa formations.

Within the limits of the Reserve there are three physiographic situations, but, because of the precipitous nature of the coast and the small size of the rivers, there is only a weak development of the Mangrove and Nipa formations. The first stages of the life history of the swamps produced by these plants are here encountered.

(*a*) *The Mangrove and Nipa-Acanthus formation behind sandy beaches.*—Situated at the mouths of the Lamao and Limay rivers, there are small areas having the *Nipa-Acanthus* formation. Although the species comprising this are most in evidence, yet the elements of the mangrove formation are not lacking. The early stages in the development of the vegetation on the strand below high tide and behind beaches, usually show among the first arrivals *Nipa fruticans* (see Pl. XI), the most important plant of the *Nipa-Acanthus* formation. The fruits of this palm have a remarkable capacity for being carried through long distances by shore currents. It is not an uncommon sight to see germinated seeds floating in the water near the beach, or lying on the latter where they have been cast up by the waves but where the dynamic conditions on the strand are too strenuous to admit of their obtaining a foothold. However, if they are carried into lagoon or tidal channels by the flow of the tide, then in these more quiet waters young plants of this species find a favorable place for development. Thus, newly formed lagoons have *Nipa fruticans* among the first pioneers, although, in many instances, grasses and sedge may precede the *Nipa* stage.

Plate XL shows a condition in which *Panicum repens, Fimbristylis ferruginea,* and *Cyperus malaccensis* form the brackish meadow. Such habitats are usually rapidly replaced by the more shrubby growths of several other plants, among which the shrubby creeper *Acanthus ilicifolius,* the hard, prickly, ilex-like leaves of which give a decided character to the formation, may be mentioned. Often, the legumes *Derris uliginosa, Caesalpina nuga,* and *Dalbergia torta,* all of which have their origin in soils less salty than that in which *Acanthus* grows, are entangled with the latter and with it, because of their scandent habit, they form dense, jungle-like and thorny thickets, which are difficult to penetrate. The ground rosettes of the fern *Acrostichum aureum* and the amaryllidaceous *Crinum asiaticum* are scattered here and there in the open

places. Among the trees, scattered specimens of *Dolichandrone spathacea, Xylocarpus granatum, Heritiera litoralis* are clearly elements of both the *Barringtonia* and the *Nipa* formations, but they are not present in the best expression of the mangrove swamps. In small rivers, the mangrove vegetation itself is wanting or poorly developed; thus, at the mouth of the Lamao River, on the Reserve, only isolated species of *Rhizophora conjugata, Avicennia officinalis,* and *Sonneratia pagatpat* were noted.

While no further stages in the development of mangrove swamps behind sandy beaches are present at Lamao, yet in many parts of the Philippines these are characteristically the feature of the vegetation at the mouths of large rivers, behind bars along exposed coasts. Their best expression shows the vegetation to be distributed in zones; *Nipa* and its associates occupying the upper limits of high tide, with none of the elements of the mangrove formation, and the latter situated in the more deeply submerged parts of the tidal area. Irregular topography, made by the smaller tidal channels, leaves hummocks at the base of which the elements of the *Nipa* formation may be encountered, on top are representatives of non-halophytic vegetation, while the channel itself is occupied by species of *Rhizophora* or *Bruguiera.*

(*b*) *Mangrove and Nipa formations at the mouths of rivers not behind beaches.*—The mouth of the Alangan River is in a re-entrant across which a subaqueous bar is being formed, which causes the breaker line to be a considerable distance from the shore (see map) and in this the water is comparatively speaking, quiet, especially on its south or more protected side. Here a considerable development of the mangrove formation which is advancing and which in time will fill up the re-entrant, is seen near the mouth of the river. Considerable hydrodynamic force is present, so that much mud has not as yet been accumulated. The substratum is consequently sandy, and this is especially true at the base of the cliffs which will be discussed below.

While the best expression of mangrove swamps is found in muddy deltas yet, as is often assumed, there is no reason to believe that such a soil is requisite for their development. It is far more true that the hydrodynamic factors which prevent the deposit of mud, also establish a too strenuous habitat for the seedling stages of the mangrove species. Other things being equal, the trees can thrive in sandy soils.

(*a*) *Mangrove formations at the mouths of rivers.*—These factors being combined at the mouth of the Alangan River, there is but a poor expression of the mangrove element in that situation. The species present are mostly *Sonneratia pagatpat* and *Avicennia officinalis.* Outside the Reserve, the best representation of this vegetation is found on delta regions at the heads of protected bays. Here the hydrodynamic elements are such as to allow the rapid capture of the newly formed mud flats. The greater the tidal area, the more extensive the advance

of that of the mangrove. In these places, as in the other situations, the *Nipa-Acanthus* formation is at the upper limits of high tide. Nearly all the species common to mangrove swamps which are found in the Indo-Malayan region, are also present in the Philippines, although not on the Reserve.

(*β*) *Mangrove formation at the base of cliffs.*—On the Lamao Reserve there are a number of shore promontories, at the bases of which wave-cut terraces have been formed, and some of these are thickly set with large bowlders offering a suitable place for the establishment of mangrove plants. The shore currents carrying the seeds or seedlings are likely, with the falling tide, to drop them in one of the interstices. The following species were noted *Ægeceras corniculatum, Sonneratia pagatpat, Ceriops candolleana, C. roxburgiana, Bruguiera eriopetala,* and *Avicennia officinalis.* The presence in this strenuous zone of a dilute expression of the mangrove formation in protected patches conclusively shows that the main cause for their absence in the tidal area near sandy beaches is not due to the nature of the soil, but to the hydrodynamic forces there present. However, because of the nature of the habitat no *closed* mangrove swamps can be observed on wave-cut terraces; only isolated trees are here and there encountered. It is even possible that on more open coasts the protection afforded by the bowlders would not be sufficient to allow the invasion of such plants.

Ecological characteristics of mangrove plants.—Schimper [60] has so thoroughly treated the peculiar characters of mangrove plants that here they need only be mentioned. They are as follows: Prevalence of viviparous seeds, pneumatophores, stilt roots, and leathery, usually opposite xerophytic leaves.

The habitat.—Undoubtedly, the main characteristic of the habitat is its salty nature and to this the peculiar formation is due. Whether other factors are operative in giving it this peculiarity is not known. It is possible that, for the edges at least, the reflection of the light from the water enhances the transpiration, but this would not be very effective for the shaded portions. Contrasted with the plants found on sandy strands, those of the mangrove swamps are undoubtedly obligatively halophytic. Observations extended over many miles of beaches show these forms to be only in salty, damp soils. It has been demonstrated that many plants growing on beaches are facultative xerophytes, but it is also true that many of them can also grow in salty soils and are therefore facultative halophytes. Copeland [61] has shown that the coconut roots are, for a short time at least, adapted to resist salt water; whether they could withstand such soils permanently is not known. However, purely mangrove vegetation can not, for any length of time, exist outside of salty soils.

[60] *Loc cit.*, 396–406.

[61] Copeland: *Loc. cit.*, 17.

Genetic relations of tidal vegetation.—It has been seen that the tidal estuaries of young rivers in the first stages show elements of the *Nipa* vegetation and that this is followed by the mangrove proper. As the delta formations grow, the mangrove captures the newly made portions and it thus steadily advances seaward. In the meantime, the landward portions of the swamps are being filled by the normal erosive forces and thus the habitat changes and with it, as a consequence, the plant formations. Thus the zone of vegetation behind, replaces *Nipa* and the latter in turn advances on the mangrove. For the Reserve, this is the *parang* of the region immediately behind these swamps. Had the original vegetation in this situation not been removed, then it would take possession. Thus extensive areas, especially the deltas of large rivers which formerly were occupied by mangrove and *Nipa* swamps, are now covered with the mesophytic forests.

Sea-cliff formation.—The vegetation of the sea cliffs has no species peculiar to this situation; rather it partakes of the characteristics of the sandy beaches and of the regions behind them. The windy nature of the habitat evokes a strictly xerophytic type. Trees such as *Vitex littoralis* (molave) (See Pl. XLI), which often occupy a place on the very edge of the cliff, show a much more stunted growth than those in less exposed places. *Erythrina indica, Terminalia catappa,* and *Pandanus tectorius* of the beach plants often find lodgment on the cliff. The inland formation furnishes *Parkia roxburghii,* species of bamboo, *Celtis* sp., *Scolopia luzonensis, Linociera cumingiana, Mimusops elengi, Cyclostemon cumingii, Cordia blancoi, Memecylon edule, Glochidon littorale, Erioglossum rubiginosum,* and others.

GENERAL CONSIDERATIONS.

Relations to climate.—It has been shown that as one ascends the mountain from the seashore to the summit, distinct climatic belts are encountered and corresponding to these belts are plant formations. The elements of the climate which leave their imprint on the type of vegetation are distinctly those of moisture. From the base up to and including the top, the rainfall and the relative humidity increase and the heat slightly diminishes as one proceeds from below upward. Save on the exposed ridge where the wind causes excessive transpiration, the climatic conditions are for this reason rendered more favorable to vegetation and therefore, one finds a forest more nearly evergreen situated well up on the mountain than one does at its foot and correspondingly, the deciduous and bamboo elements become less pronounced. It may seem presumptuous at this time to make comparisons with the vegetation of other portions of the Islands, yet a hasty trip to parts of the east coast of Luzon previous to and valuation surveys made on the east coast of Mindoro since the collection of data for this paper, clearly show that the climatic formations found well up the slopes of Mount Mariveles are in both the

other places near the sea level. This difference is in direct response to the less-pronounced dry season in these situations. Thus, on the east coast of Tayabas (sub-province Infanta) trees such as *Dipterocarpus grandiflorus* of the *Dipterocarpus-Shorea* formation, *Agathis philippinensis* of the *Shorea-Plectronia* and *Tristira decorticata* of the *Eugenia-Vaccinium* are fairly represented in the forests below 100 meters. On the east coast of Mindoro, *Shorea polysperma* and *Shorea contorta* are not only present near sea level but in many places they have succeeded in obtaining a foothold on old beach lines. In this portion of the Island, also, *Asplenium nidus, Ophioglossum pendulum* and associated species are present at the same lower altitude and in the valley of the Tinguan River, in the sub-province of Infanta, near sea level, *Myrmecodia echinata, Nepenthes alata,* other related epiphytes and *Decaspermum paniculatum,* are encountered. These examples suffice to illustrate the fact that many plants found on the upper slopes of the mountain are also present near the level of the sea when the moisture conditions are favorable for their existence in this situation. Again, so far as my observation goes, in those places in which the dry season is less pronounced, the very characteristic bamboo forests at the base of Mount Mariveles are entirely absent, being replaced by forests which show a very much less deciduous element. Thus, portions of the east coast of Luzon have no bamboo forests, whereas they are present in other parts where the dry season is pronounced. *Parkia roxburghii,* while it is found scattered in evergreen forests on the east coast of Mindoro, nevertheless shows a change in habit. Instead of being deciduous for two or three months, as is the case at Lamao, there, in many instances, the new leaves appear as soon as the old ones have been shed, and on the dry, sandy soils of old beaches, the interval of time between the shedding of old and the appearance of new leaves was at the time of observation, never more than two weeks.

Relations to topography.—In the discussion of each climatic formation, attention has been called to the physiographic situations in which the vegetation is less or more mesophytic. Thus, exposed ridges and steep exposed slopes have not only drier soils but drier atmospheres, and consequently the vegetation in these places is much thinner and more xerophytic. As the physiographic forces at work bring them into more stable and less exposed conditions, their vegetation will lose its xerophytic character and gradually assume that of the climax vegetation of the formation. The main rivers draining the mountain, cut the climatic formations at right angles and in their beds and in the cañons thus formed, a local climate which is more or less nearly uniform throughout the length of the stream, is produced. The ecological character of the vegetation throughout such river beds and those of the side streams is alike and the latter shows closer relations than are to be found in any one formation in relation to the other vegetation in that formation. This is due to both edaphic and atmospheric characters. The proximity

of the underground water level to the surface makes a common habitat for plants which require this condition. Thus, irrespective of altitude, one finds plants which apparently belong to the low land extending up the stream as far as the habitat goes. Such trees as *Sarcocephalus cordatus, Bischofia trifoliata, Mangifera altissima,* and *Eugenia luzonensis* are found scattered from near the sea level up to an altitude of approximately 700 meters and they are seldom encountered in other situations.

Ficus minahassæ, other species of *Ficus, Leucosyke capitellata,* and *Pipterus asper* are encountered in similar situations from a point near the level of the sea up to 900 meters and *Homonoya riparia* grows in the bed of the stream itself up to the 500-meter line. (See Pl. XLII.)

No doubt, many of these plants would flourish throughout the entire length of the stream, were the edaphic habitat which is necessary for their growth existent at higher altitudes. Aside from the edaphic moisture, the protected position of the cañon renders the atmospheric moisture more uniform and corresponding to this, trees and other plants requiring moisture conditions obtaining in higher altitudes are also present in low ones on the slopes of the cañon farther down the mountain and, at these altitudes, such trees and plants are found in no other situations. The tree fern *Alsophila contaminans,* the very large *Angiopteris crassipes,* and other plants offer striking examples of this fact. (See Pl. XXIV.) Indeed, the vegetation of the river bed and of the cañons in any one climatic formation resembles that of similar habitats in the other formations more than it does that adjacent to it. As yet, the river habitat of the Lamao Reserve is a narrow one. As the mountain more nearly approaches base-level condition, flood plains will be established and thus the edaphic habitat having soil moisture near the surface will be enlarged. A comparison of the Lamao River vegetation with that of the Boñgabon River on the east coast of Mindoro, where the base-level condition has nearly been reached, shows that nearly all tree species, common and peculiar to the habitat near the Lamao River and on the lower slopes of the canyons, reach a much better development near the Boñgabon River flood plain than they do near the Lamao River. Indeed, the vegetation of the Boñgabon River flood plain is that of the Lamao River, spread out. Of course, this larger habitat offers space for more species, but practically all of those found on the narrow margin of the Lamao River are also present in greater numbers near the Boñgabon and there give character to the vegetation.

General conclusions.—Schimper[62] has divided formations into climatic and edaphic, the one depending on the climate, the other on the conditions of soil; thus, within each general climate, there are peculiar conditions of soil such as those pertaining to the mangrove swamps and

[62] Schimper: *Loc. cit.*, 161 and 177.

sandy beaches, which have an especial vegetation more or less independent of the climate in which it grows. Cowles [63] enlarges this idea so as to include all types of topography in the process of destruction and which, consequently, in their present condition, offer unstable and therefore temporary habitats for plants. The vegetative condition will become stable only when base-level conditions are approximated. Thus, the cañons on the one hand have a temporary, mesophytic vegetation and the steep slopes a temporary xerophytic one. The top of the mountain is exceedingly unstable and therefore the vegetation is temporary. Traced to its logical conclusions, the physiography of the entire mountain is very unstable and therefore the vegetation is temporary. With its destruction, it will pass to a more and more permanent condition and the vegetative types will be altered with the change in topography; the climate will then also be different and will more nearly approximate that at present prevalent at the base; and therefore the erosive topography at old age will have a vegetative condition not unlike that of the *Bambusa-Parkia* formation. Just before the death of such a topography, the whole country will be brought nearly to a base-level with the ground water not far from the surface. The vegetative condition will then be not unlike that of a delta region, of which there are many fine examples in the Philippines. At death itself, the mangrove swamps will probably prevail. Of course, the above are only theoretical considerations, yet these erosive stages are approximated in different parts of the Islands so that when logically united the genetic relations of the different vegetative formations can be made clear.

(The work on which this paper was based was performed while the writer was a member of the staff of the Bureau of Science. It was in part written after his transfer to the Bureau of Forestry.)

[63] Cowles, H. C.: The Physiographic Ecology of Chicago and Vicinity. *Bot. Gaz.* (1901), **31**: 75.

ILLUSTRATIONS.

PLATE XXVIII. On the left is a large tree of *Shorea polysperma* (tanguili), on the right in background is *Eugenia glaucicalyx*. Other smaller trees are *Cinnamomum mercadoi* and *Baccaurea tetrandra*. Rattans (*Calamus*) are also present. *Dipterocarpus-Shorea* formation.

XXIX. Narrow ridge between two ravines on the slopes of the main ridge. See Table XIX, Plot F. On the left is a tree of *Cryteronia cumingii*, in the center is *Hopea acuminata* (dalindingan), and on the left is *Quercus* sp. Young trees of *Ardisia, Cinnamomum, Hopea,* and *Cryteronia* are present. A very unstable habitat in the *Shorea-Plectronia* formation.

XXX. A side ravine near the habitat shown in Plate XXIX. The large fern is a *Dennstaedtia* species. The habitat is a newly formed one well protected from strong insolation.

XXXI. View of the eroding bank of the Lamao River at 100 meters altitude. At the base *Nephrodium philippinense*, above this the aroid *Schizmatoglottis rupestris*. *Freycinetia ensifolia* is on the left. *Begonia rhombicarpa* is also present. Compare with Plate XXXII. *Anisoptera-Strombosia* formation.

XXXII. Side ravine in *Shorea-Plectronia* formation. Altitude about 600 meters. On the face of the damp rocks *Gymnopteris inconstans* is abundant, with a small species of Selaginella. In the center is *Schizmatoglottis rupestris*, to the right is *Polybotrya appendiculata*, and above is *Freycinetia ensifolia*. Compare with Plate XXXI.

XXXIII. View in the bed of the cañon of the Lamao River. On the left is a dry rock mostly showing lichens, on the right there is more or less seepage from the rock. Here are found *Schizmatoglottis rupestris* and the delicate urticaceous shrub *Elatostema whitfordii*. On a tree in the background is shown a specimen of the bird's-nest fern, *Asplenium nidus*.

XXXIV. View of the "elfin" forest at 920 meters' altitude. Trees are *Eugenia acuminatissima* var. *parva, Machilus philippinensis, Canarium villosum, Excoecaria philippinensis, Clethra lancifolia*, and others. *Eugenia-Vaccinium* formation.

XXXV. View of rock outcrop. See Plot B, Table XXIII. Note the manner in which the roots of a *Ficus* sp. hold the rocks. Tree in center is *Eugenia acuminatissima*. *Polypodium meyenianum* on the rocks above. Note lichens on the rocks. *Eugenia-Vaccinium* formation.

XXXVI. View on the ridge at 1,100 meters. The grass-like orchid *Acoridium tenellum* is growing on *Eugenia congesta*. Above *Acoridium* is another orchid, *Cestichis* sp.; on the left below is a young specimen of the fern *Cyathea caudata*. Note mosses and liverworts. *Eugenia-Vaccinium* formation.

PLATE XXXVII. "Elfin" forest near top of Mount Mariveles. The tree species are mostly *Eugenia congesta, Adinandra luzonica,* and *Vaccinium jagori.* Note the rich development of mosses, liverworts, and "filmy" ferns on the trunks of trees. *Eugenia-Vaccinium* formation.

XXXVIII. Epiphytic vegetation on Mount Mariveles. Note the orchid (unknown sp.) on the branch of *Leptospermum amboinense.* On this branch in the center is a seedling of *Vaccinium jagori;* on the right, slightly out of focus, is the orchid *Acoridium tenellum.* A moss, *Ærobryum lanosum,* and a small creeping fern, *Humata repens,* are also common on the same branch. Below is a mass of the filmy fern, *Hymenophyllum* sp., now dried up. In this are *Humata, Selaginella, Rhododendron quadrasianum,* the moss *Leucobryum javense,* and the liverworts *Mastigophora diclados* and *Bazzania praerupta. Eugenia-Vaccinium* formation.

XXXIX. Specimen of the bird's-nest fern *Asplenium nidus* growing on *Eugenia acuminatissima. Eugenia-Vaccinium* formation.

XL. View at the mouth of the Lamao River. Note the meadow in the center, back of which is the *Nipa-Acanthus* formation. On the left are elements of both Nipa and Mangrove swamps. In the background the bamboo *Bambusa blumeana.*

XLI. View of a sea cliff near the mouth of the Lamao River. The large tree on the edge is *Vitex littoralis* (molave), below it on the right is *Pandanus tectorius.* On the left is *Bambusa lumanpao.* The waves and shore currents on the terrace at the base are too strong to permit the mangrove vegetation to obtain a foothold.

XLII. View in the rocky river bed of the Lamao River showing the peculiar habit of *Homonoya riparia.* The floods of the rainy season repeatedly strip this tree of its leaves. The fern shown in the picture is *Callipteris esculenta.*

XLIII. A—Leaves of *Buchanania florida.* 1, grows in protected position at 180 meters; 2, taken from a tree growing on an exposed ridge at 914 meters. B—Leaves of *Calophyllum whitfordii.* 1, taken from tree on a protected ridge at 640 meters; 2, taken from a tree growing on a protected ridge at 1,100 meters; 3, taken from a tree on an exposed peak at 914 meters; two-thirds natural size.

XLIV. A—Leaves of *Myrica rubra.* 1 and 2 from the same tree at 640 meters; 1, from the lower shaded branches, and 2 from an upper branch; 3, taken from a tree at 1,150 meters. B—Leaves of *Ternstroemia toquian.* 1, taken from a tree on exposed peak at 920 meters; 2, from a tree on protected slope at 640 meters; two-thirds natural size.

XLV. A—1, 2, and 4, leaves of tree *Eugenia acuminatissima;* 1, taken from tree growing on protected slope at 940 meters; 2, at 815 meters, and 4, at 1,060 meters; 3, leaf of tree of *Eugenia acuminatissima* var. *parva,* taken from a tree growing on exposed peak at 920 meters. B—Leaves of *Eugenia congesta.* C—1, leaves of tree of *Leucosyke capitellata* var. *celtidifolia* growing on edge of a cliff at 920 meters; 2, leaf of *Leucosyke capitellata* growing near the bottom of the river cañon at 635 meters. Two-thirds natural size.

PLATE XXVIII.

PLATE XXIX.

PLATE XXX.

PLATE XXXI.

PLATE XXXII.

PLATE XXXIII.

PLATE XXXIV.

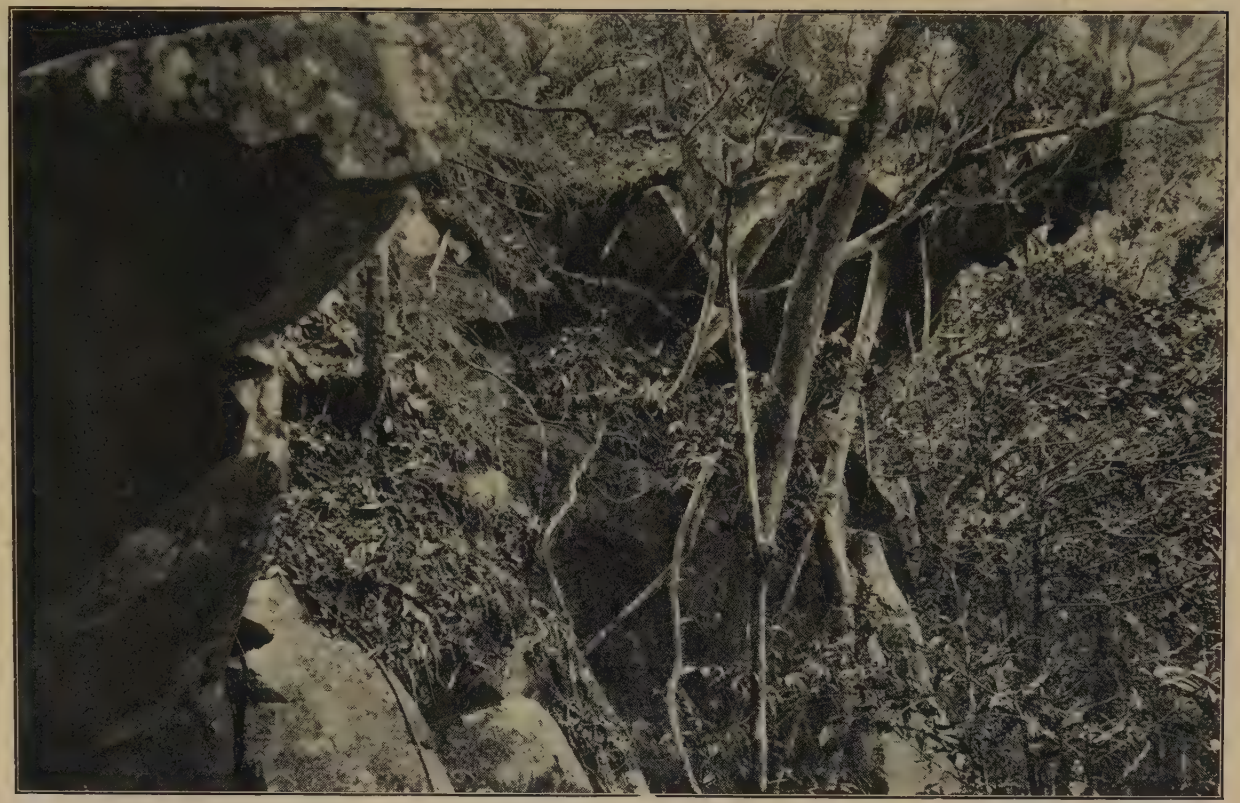

PLATE XXXV.

PLATE XXXVI.

PLATE XXXVII.

PLATE XXXVIII.

PLATE XXXIX.

PLATE XL.

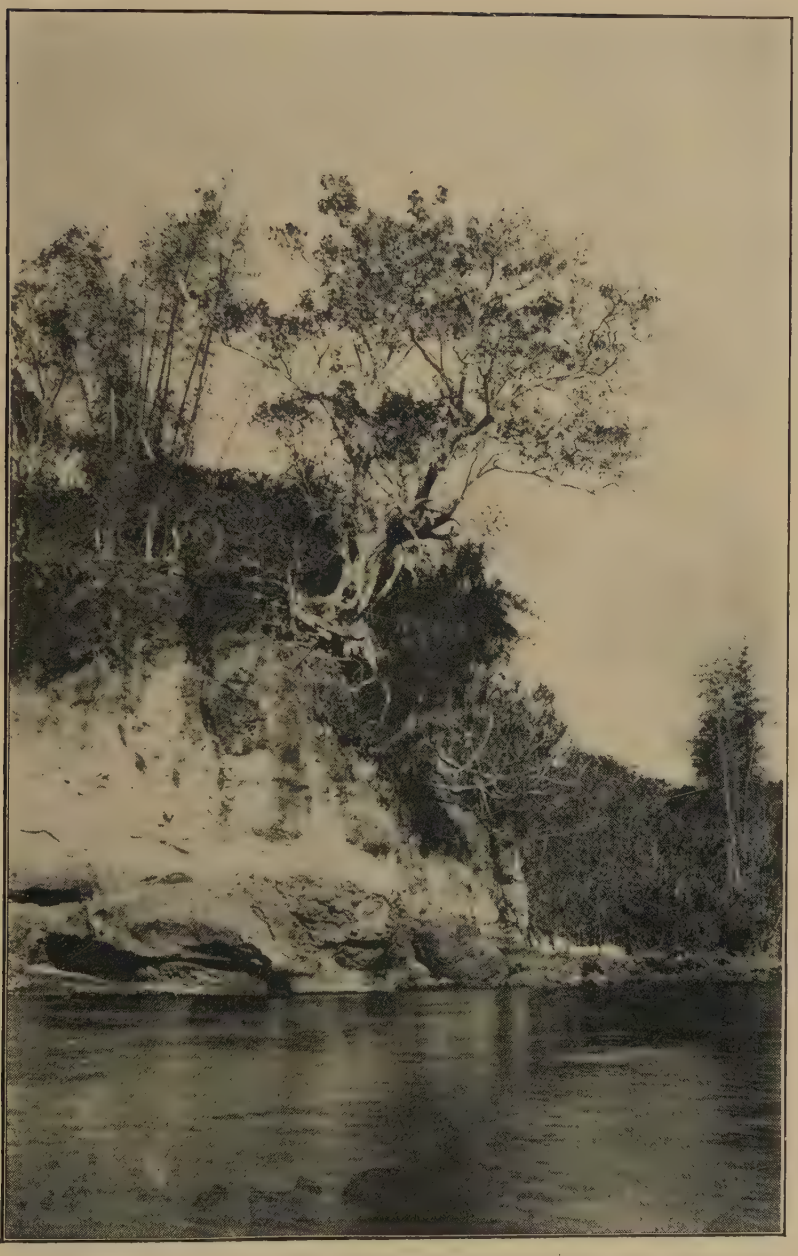

PLATE XLI.

PLATE XLII.

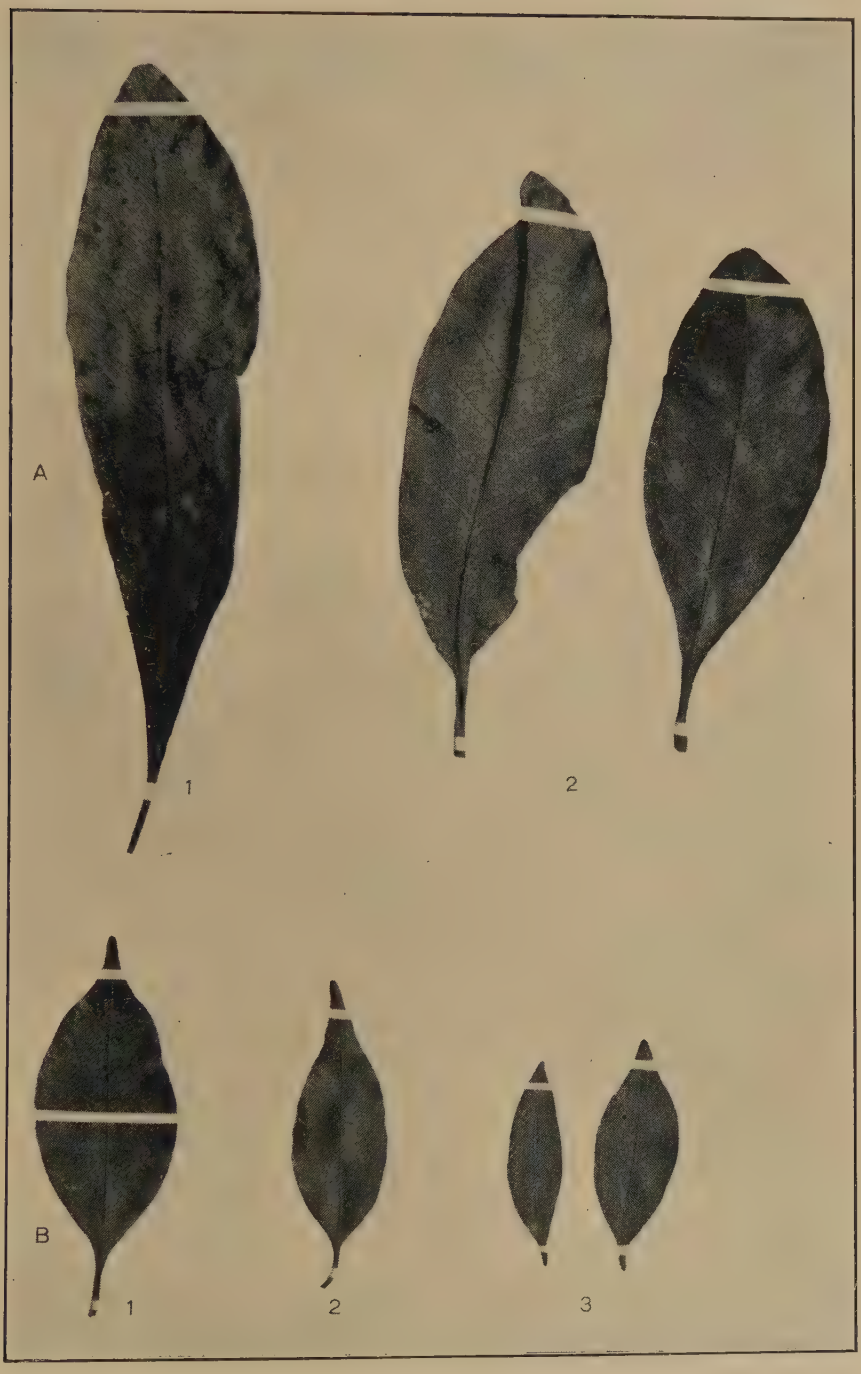

PLATE XLIII.

PLATE XLIV.

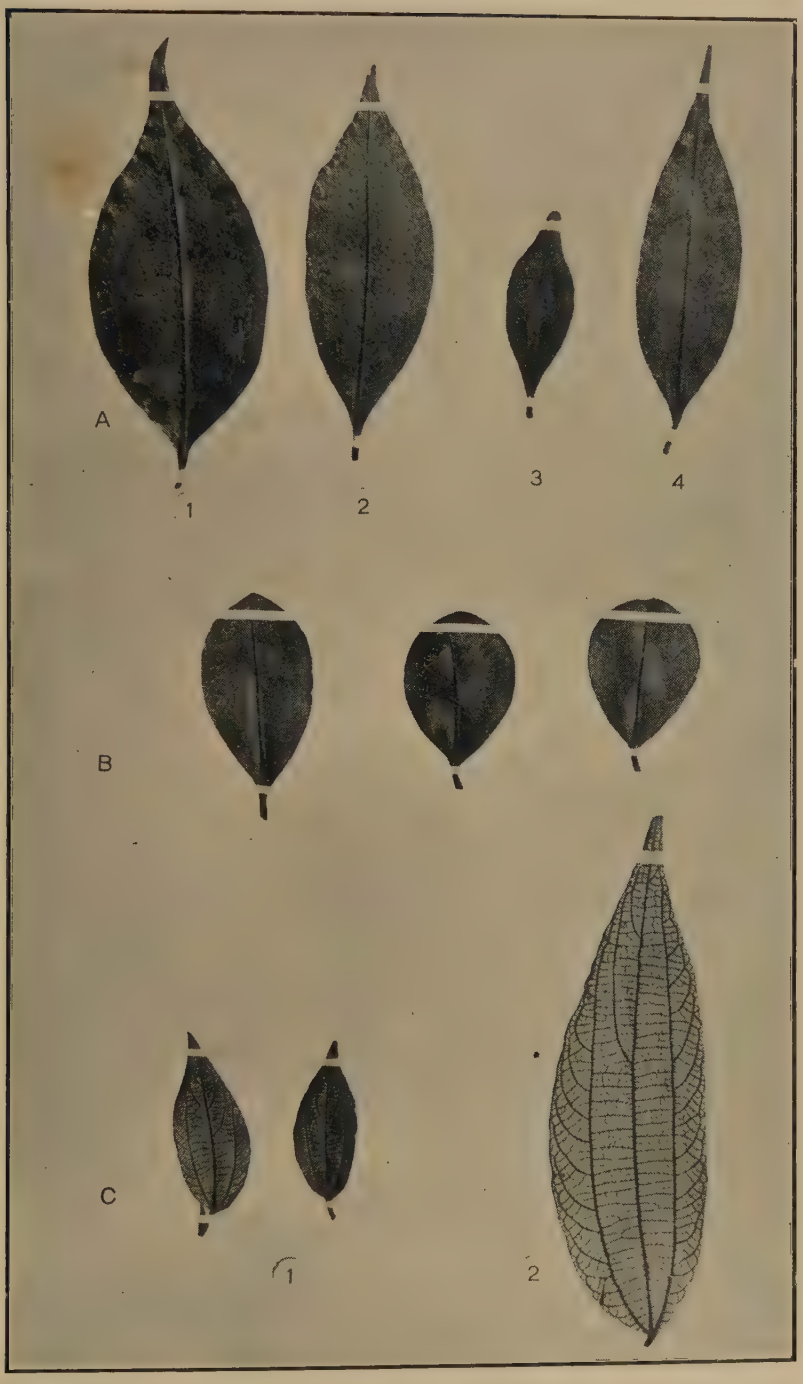

PLATE XLV.

A CATALOGUE OF PHILIPPINE HYMENOPTERA, WITH DESCRIPTIONS OF NEW SPECIES.

By Robert E. Brown, S. J., *Manila Observatory.*

In 1885, Don Ramon Jordana published in Madrid a work entitled "Bosquejo geográfico é histórico-natural del Archipiélago Filipino," in which he tabulated all the species then known to belong to the Philippine fauna. The order *Hymenoptera* was very poorly represented, no more than some thirty species being given as having been met with in the Philippines and none of these were characteristic. Ten years later, on the occasion of the exposition which was held in Manila in 1895, Father Castro de Elera, O. P., published another catalogue of the fauna of the Islands, which he entitled "Catálogo sistemático de toda la fauna de Filipinas conocida hasta el presente." This work is much more pretentious and complete than that of Señor Jordana, though it is somewhat marred by the inclusion of many exotic forms which were contained in the Museum of the University of Saint Thomas; and although Father Elera explains this in the subtitle and notes the exotic species in the body of the work, still, unless one has this constantly before one's mind, the impression is gained that the number of Philippine species is greater than it really is. In the catalogue of the *Hymenoptera* which is given in the second volume, pages 238–247, Father Elera enumerates fifty-four species as representing the known Philippine insects of this order. This is not quite correct, as he had inadvertently overlooked a paper published by Professor Emery in the Annals of the Entomological Society of France in 1893 in which forty-one species of ants are recorded from the Island of Luzon, principally from Manila and Antipolo.

This then brought the *Hymenoptera* known in the Archipelago up to the year 1895 to the number of ninety-five.

In 1903, Rev. William Stanton, S. J., at that timé Assistant Director of the Philippine Weather Bureau, began to study in his spare time the *Hymenoptera* which he collected in the garden attached to the Observatory. He discovered many forms which he did not recognize, and, being unable to classify them owing to the lack of literature on the subject, he sent his specimens to Dr. William Ashmead, of the National Museum, Washington, who found that the great majority of the species were entirely new to science and that almost all the remainder were not before recorded from the Islands.

Father Stanton continued the work till April, 1904, when he was obliged to return to the United States, but in the short time he had been collecting he had discovered no less than five new genera and sixty-eight new species.

The descriptions of the earlier of these new species were published by Dr. Ashmead in the Journal of the New York Entomological Society and of the later collections in the Canadian Entomologist and the Proceedings of the United States National Museum.

When Father Stanton left the Philippines, the writer continued his work and as a consequence the number of new genera and new species has greatly increased; in fact, from December to June, which constitutes the best collecting season, the average of new species was one per day and of new genera three every two months.

The number of species in the adjoined catalogue is 458. Many are included which were not contained in Dr. Ashmead's check list, as he had apparently overlooked several recorded by Kohl, Ritsema, and Radoszkowski, while species not before recorded from the Philippines are being constantly discovered. However, this number does not represent the complete hymenopterous fauna, for the writer has in his possession some thirty-nine new species which have not as yet been described, while the Entomological section of the Bureau of Science has many more undescribed forms.

After the name of the species discovered since 1903 I have placed the name of the collector and in the case of those found by Father Stanton and the writer, M. O., to show that they were obtained from the garden of the Manila Observatory. At the end of the catalogue will be found a list of some of the hosts from which a few of the new species were bred in the Observatory.

Superfamily III. **VESPOIDEA.**

Family XXVII. CEROPALIDÆ.

Subfamily III. Aporinæ.

Tribe I. Anopliini.

TACHYPOMPILUS Ashmead.

Tachypompilus ashmeadii sp. nov. ♀ Length, 14–16 millimeters. Head, thorax, and part of abdomen black, last 3 segments of abdomen brick red, covered with sparse pubescence, the pubescence consisting of straight, longish hairs; head smooth, pronotum lightly rugose, scutellum, metanotum and abdomen finely punctate, shining. Clypeus truncate, smooth. Scape stout, first joint of flagellum twice as long as the second, front face long, with a deep medial furrow. Anterior face of metathorax convex, posterior face concave with the angles obtusely dentate. Wings hyaline with nervules fuscous, median and submedian cells of equal length. Three cubital cells, first almost triangular, second quadrangular and third very large; hind tibia sparsely armed with spines, first joint of hind tarsi as long again as any of the rest, claws reddish. Manila.

Family XXXI. CHRYSIDIDÆ.

Subfamily II. CHRYSIDINÆ.

CHRYSIS Linn.

Chrysis miri sp. nov. ♂ Length, 6.5 millimeters. Near to *C. mendicalis* Cameron. Head, thorax, first and third abdominal segments, light metallic blue; space around ocelli, a few punctures on collar and pronotum, medial area of scutellum and second abdominal segment purple; round spot and apical margin of third segment purple, with a transverse line on basal area of second segment, dark purple.

Antennæ black, the scape in front and two basal joints of flagellum light bronze green; coxæ and femora of front legs metallic green; tibiæ slightly green; tarsi dark brown, tibia with slight cinerous pubescence; hind legs green, tarsi brownish. Head and thorax with closely set, coarse punctures, with smaller ones scattered up and down, the punctures larger on posterior portion of thorax, smaller on the abdomen and very symetrically arranged. The ventral segments very finely punctate, with a brown medial longitudinal ridge along all the segments.

Antennæ thick, the third joint of the flagellum as long again as the second. Pronotum broad, very much rounded anteriorly, medial area of mesonotum separated from the lateral areas by longitudinal rows of purple punctures; scutellum and post-scutellum convex, posterior portion of post-scutellum very much rounded.

First abdominal segment with a medial wide and deep depression anteriorly. Apical segment of third segment with 3 teeth, one on each angle and one in the middle, the intervals between the teeth sinuate.

Family XLII. MUTILLIDÆ.

Subfamily I. MUTILLINÆ.

MUTILLA Linn.

Mutilla manilensis sp. nov. This species comes very near to *M. vicinissima* Gribodo but is differentiated by the size of the maculæ and the bands of pubescence on the third and fifth segments. ♀ Length, 7.5 millimeters. Head broader than thorax. Head and thorax coarsely, abdomen finely, punctured. Scape, femora, head posteriorly, thorax and abdomen densely pubescent. Head, antennæ, abdomen and legs black, thorax red; pubescence on abdomen cinerous, on legs and antennæ whitish.

The second abdominal segment above with 2 small, round, silvery maculæ; the third and fifth segments covered with transverse bands of silvery pubescence. The first ventral segment with a prominent longitudinal carina, the fourth and fifth segments coarsely punctate posteriorly and striated anteriorly.

Mutilla parva sp. nov. Near to *M. decora* Smith. ♀ Length, 4.5 millimeters. Head and abdomen finely, and thorax coarsely, punctate and sparsely pubescent, the pubescence consisting of thin, long, curved hairs. Eyes, large, oval; thorax very much rounded, abrupt anteriorly and with a steep slope posteriorly; head and antennæ black, except the scape which is rufous covered with whitish pubescence; legs, except the femora, and abdomen black, thorax red.

A small oval silvery-white spot in the middle above on the second abdominal segment, a transverse band of silvery-white pubescence which is interrupted medially on its posterior margin, and the third segment also covered with the white pubescence. First, third, and fourth ventral segments strongly longitudinally carinate.

Order HYMENOPTERA.

Suborder I. **Heterophaga** Ashmead.

Superfamily I. Apoidea.

Family I. APIDÆ.

Megapis dorsata Fabricius.
zonata Smith.
Apis indica Fabricius.
mellifera Linnaeus.
nigrocincta Smith.
unicolor Latreille.
Micrapis florea Fabricius.
Trigone biroi Friese.
Melipona laeviceps Smith.

Family II. BOMBIDÆ.

Bombus mearnsi Ashmead; E. A. Mearns.

Family V. ANTHOPHORIDÆ.

Anthophora cingulata Fabricius.
zonata Linnaeus.

Family VI. NOMADIDÆ.

Crocisa emarginata Lepeletier.
lamprosoma Boisduval.
nitidula Fabricius.
Nomada lusca Smith.
philippinensis Vachal.
Nomia dimidiata Vachal.

Family VII. CERATINIDÆ.

Ceratina compacta Smith.
hieroglyphica Smith.
imperialis Ashmead; M. O.
philippinensis Ashmead; M. O.
sexmaculata Smith.
tropica Ashmead; M. O.
Allodape jucunda Smith.
minutior Ashmead; M. O.
philippinensis Ashmead; M. O.

Family VIII. XYLOCOPIDÆ.

Xylocopa aestuans Linnaeus.
adusta Perez.
amauroptera Perez.
bombiformis Smith.
bryorum Fabricius.
Xylocopa dissimilis Lepeletier.
euchlora Perez.
fuliginosa Perez.
ghilianii Gribodo.
latipes Fabricius.
occipitalis Perez.
philippinensis Smith.
sonorina Smith.
sulcifrons Perez.
rufescens Smith.
tricolor Ritsema.
trifasciata Gribodo.
vachali Perez.
Platynopoda latipes Drury.
tenuicornis Westwood.

Family IX. MEGACHILIDÆ.

Megachile atrata Smith.
clotho Smith.
hera Bingham.
lachesis Smith.
laticeps Smith.
robbii Ashmead; M. L. Robb.
Ctenoplectra vagaus Cockerell.

Family X. STELLIDÆ.

Coelioxys manilae Ashmead; M. O.
philippinensis Bingham.

Family XII. ANDRENIDÆ.

Hoplonomia quadrifasciata Ashmead; M. O.
Paranomia stantoni Ashmead; M. O.
Halictus manilae Ashmead; M. O.
robbii Ashmead; M. L. Robb.

Family XIV. PROSOPIDÆ.

Prosopis tagala Ashmead; C. S. Banks.

Superfamily II. Sphecoidea.

Family XV. OXYBELIDÆ.

Notoglossa banksi Ashmead; C. S. Banks.

Family XVI. CRABRONIDÆ.

Subfamily III. Crabroninæ.

Crabro quadriceps Bingham.
venans Kohl.

Subfamily IV. Rhopalinæ.

Dasyproctus philippinensis Ashmead; M. O.
Rhopalum albocollaris Ashmead; M. O.

Family XVII. PEMPHREDONIDÆ.

Psen algii Ashmead; M. O.

Family XVIII. BEMBICIDÆ.

Bembex borrei Handlsch.
melancolica Smith.

Family XIX. LARRIDÆ.

Subfamily I. Larrinæ.

Notogonia laboriosa Smith.
manilae Ashmead; M. O.
subtessalata Smith.
Larra aurata Fabricius.
Threosphex stantoni Ashmead; M. O.

Subfamily IV. Pisoninæ.

Pison lagunae Ashmead; M. O.; P. L. Stangl.
punctatus Ashmead; M. O.
Pisonitus argenteus Ashmead; P. L. Stangl.
Pisonoides browni Ashmead; M. O.

Family XX. PHILANTHIDÆ.

Subfamily I. Cercerinæ.

Cerceris vafra Bingham.

Family XXI. TRYPOXYLIDÆ.

Trypoxylon bicolor Smith.
elongatum Ashmead; M. O.
philippinensis Ashmead; M. O.

Family XXII. MELLINIDÆ.

Megalomma quadricinctum Ashmead; M. O.

Family XXV. SPHECIDÆ.

Subfamily I. Sphecinæ.

Sphex argentata Dahlbom.
aurulentus Fabricius.
(*a*) *var.* ferrugineus Lepeletier.
(*b*) *var.* lineolus Lepeletier.
sericeus Fabricius.
sulciscuta Gribodo.
splendidus Kohl.
umbrosus Christ.
(*a*) *var.* plumbiferus Costa.
(*b*) *var.* rufipennis Fabricius.
Chlorion lobatum Fabricius.

Subfamily II. Ammophilinæ.

Ammophila atripes Smith.
coronata Costa.
superciliaris Saussure.

Subfamily III. Sceliphroninæ.

Sceliphron bengalensis Dahlbom.
madraspatanum Fabricius.
var. conspicillatum Costa.
violaceum Fabricius.
Chalybion violaceum Dahlbom.

Family AMPULICIDÆ.

Subfamily Ampulicinæ.

Ampulex compressa Fabricius.
laevigata Kohl.
sonneratii Kohl.

Superfamily III. Vespoidea.

Family XXVII. CEROPALIDÆ.

Subfamily I. Pepsinæ.

Salius flavus Fabricius.
graphicus Smith.
pulchripennis Smith.
Hemipepsis tagala Gribodo.
Pallosoma fulgidipennis Saussure.
Pseudosalius bipartitus Lepeletier.
Caligurgus sericosoma Smith.

Subfamily II. Ageniinæ.

Macromeris argentifrons Smith.
splendida Lepeletier.
violacea Lepeletier.

Pseudagenia femorata Ashmead; M. O.
imitator Ashmead; M. O.
rufofemorata Ashmead; M. O.
unifasciata Ashmead; M. O.
Spilopompilus stantoni Ashmead; M. O.
Agenia cingulata Ashmead; M. O.

Subfamily III. APORINÆ (*Pompilinæ*).

Tribe I. *Anopliini.*

Tachypompilus ashmeadii Brown; M. O.

Family XXVIII. VESPIDÆ.

Subfamily I. VESPINÆ.

Vespa analis Fabricius.
annulata Smith.
cincta Fabricius.
deusta Lepeletier.
luctuosa Saussure.
nigripennis Saussure.
philippinensis Saussure.
Provespa dorylloidea Saussure.

Subfamily II. POLISTINÆ.

Polistella manilensis Saussure.
Polistes dubius Saussure.
hebraeus Fabricius.
philippinensis Saussure.
Icaria cagayanensis Ashmead; M. O.
philippinensis Saussure.
speciosa Saussure.

Family XXIX. EUMENIDÆ.

Subfamily IV. EUMENINÆ.

Eumenes conica Fabricius.
curvata Saussure.
fulvipennis Smith.
gracilis Saussure.
pomiformis Fabricius.
Rhynchium argentatum Fabricius.
atrum Saussure.
Lionotus dyscherus Saussure.
punctum Saussure.
xanthozonatus Ashmead; M. O.
Ancistrocerus bizonatus Boisduval.
Odynerus punctum Saussure.

Family XXXI. CHRYSISIDÆ.

Subfamily II. CHRYSISIDÆ.

Stilbum cyanurum Fabricius.
amethystinum Fabricius.
splendidum Fabricius.
Chrysis fuscipennis Brullé.
miri Brown; M. O.
oculata Fabricius.
var. sumptuosa Gribodo.
triacantha Moscary.
Trichrysis aspera Brullé.
Hedychrum stantoni Ashmead; M. O.

Family XXXII. BETHYLIDÆ.

Subfamily I. BETHYLINÆ.

Dissomphalis tibialis Ashmead; M. O.
Epyris tagala Ashmead; C. S. Banks.
Giniozus philippinensis Ashmead; M. O.

Subfamily II. DRYININÆ.

Dryinus brownii Ashmead; M. O.
stantoni Ashmead; M. O.

Family XXXIII. TRYGONALIDÆ.

Trigonalys lachrymosa Westwood.

Family XXXVI. SCOLIIDÆ.

Discolia aureipennis Lepeletier.
erratica Smith.
modesta Smith.
Scolia aurulenta Smith.
capitata Guerin.
grossa Fabricius.
manilae Ashmead; M. O.
modesta Smith.
procera Illiger.
var. bimaculata Gribodo.
pseudoforaminata Gribodo.
quadrifasciata Fabricius.
quadripustulata Fabricius.
rubiginosa Fabricius.
scutellaris Gribodo.
whiteheadii Bingham.

Subfamily II. Elidinæ.

Elis albicollis Christ.
annulata Fabricius.
aureicollis Lepeletier.
aurulenta Smith.
grossa Smith.
luctuosa Smith.
quadrifasciata Fabricius.
reticulata Cameron.
Liacos analis Fabricius.

Family XXXVII. TIPHIIDÆ.

Tiphia compressa Smith.
intrudens Smith.

Family XLII. MUTILLIDÆ.

Subfamily II. Mutillinæ.

Mutilla accedens Sichel.
analis Lepeletier.
dimidiata Lepeletier.
discreta Cameron.
luzonica Radoszhowski.
maculosofasciata Saussure.
manilensis Brown; M. O.
parva Brown; M. O.
philippinensis Smith.
semperi Ashmead; M. O.
suspiciosa Smith.
Trogaspidia bicolor Ashmead; C. S. Banks.
minor Ashmead; C. S. Banks.

Superfamily IV. Formicoidea.

Family XLIV. PONERIDÆ.

Subfamily I. Ponerinæ.

Ponera luteipes Mayr.
Microponera nigriceps Ashmead; M. O.

Subfamily II. Pachycondylinæ.

Diacamma geometricum.
var. viridipurpureum Emery.
versicolor Smith.
Odontoponera denticulata Smith.
transversa Smith.
Bothroponera glabripes Emery.

Family XLV. ODONTOMACHUS.

Odontomachus haematodes Linnaeus.
infandus Smith.
papuans Emery.

Family XLVI. MYRMICIDÆ.

Subfamily I. Pseudomyrmicinæ.

Sima allaborans Walker.

Subfamily II. Myrmicinæ.

Monomorium destructor Jerdon.
Pheidole simoni Emery.
Cremastogaster bicolor Mayr.
crassicornis Emery.
longiclava Emery.
ochracea Mayr.
semperi Emery.
simoni Emery.
Pheidologeton diversus Jerdon.
pygmaeus Emery.
var. albipes Emery.
Plagiolepis longipes Jerdon.
Tetramorium guinensis Talrimis.
pacificum Mayr.
subsp. subscabrum Emery.
Solenopsis geminata Fabricius.

Family XLVIII. DOLICHODERIDÆ.

Dolichoderus bituberculatus Mayr.
tuberculatus Mayr.
Technomyrmex albipes Smith.
Tapinoma melanocephalum Fabricius.

Family XLIX. FORMICIDÆ.

Subfamily II. Camponotinæ.

Camponotus cinerascens Fabricius.
gigas Latreille.
nigricans Roger.
pallidus Smith.
platypus Roger.
pennsylvanicus De Geer *var.* japonicus Mayr.
quadrisectus Smith.
Oecophylla smaragdina Fabricius.
var. subnitida Emery.
Calobopsis albocincta Ashmead; M. O.
pubescens Mayr.
Dinomyrmex gigas Latreille.

Polyrhachis abdominalis Smith.
aciculata Smith.
argentia Mayr.
armata Le Guillon.
bicolor Smith.
bihamata Drury.
cyaniventrus Drury.
dives Smith.
maligna Smith.
mayri Roger.
philippinensis Smith.
pubescens Mayr.
rastellata Smith.
sexspinosa Latreille.
trinax Roger.
subsp. javana Mayr.
subsp. sayonensis Forel.

Subfamily III. Formicinæ.

Plagiolepis longipes Jerdon.
Aphomyrmex emeryi Ashmead; M. O.
Formica quadrisecta Smith.
rubra Fabricius.

Superfamily V. Proctotrypoidea.

Family LIV. DIAPRIIDÆ.

Diapria manilae Ashmead; M. O.
palida Ashmead; M. O.
philippinensis Ashmead; M. O.
tagala Ashmead; M. O.
Galesus luzonicus Ashmead; M. O.

Family LV. CERAPHRONIDÆ.

Ceraphron manilae Ashmead; M. O.

Family LVI. SCELIONIDÆ.

Subfamily III. Teleasinæ.

Prosacantha roberti Ashmead; M. O.

Subfamily IV. Scelioninæ.

Macroteleia manilensis Ashmead; M. O.
Opithacanta manilae Ashmead; M. O.
nigriclavata Ashmead; M. O.
Telenomus catacanthae Ashmead; M. O.
Hoploteleia pacifica Ashmead; M. O.
Hadronotus flavipes Ashmead; M. O.
luteipes Ashmead; M. O.
Scelio philippinensis Ashmead; M. O.

Family LVII. PLATYGASTERIDÆ.

Anopedias luzonicus Ashmead; M. O.

Superfamily VI. Cynipoidea.

Family LVIII. FIGITIDÆ.

Subfamily V. Eucoelinæ.

Pentamerocera pacifica Ashmead; M. O.
Hexamerocera kiefferi Ashmead; M. O.
philippinensis Ashmead; M. O.
Kleidotoma philippinensis Ashmead; M. O.

Subfamily VI. Xystinæ.

Loboscelidia rufescens Westwood.

Superfamily VII. Chalcidoidea.

Family AGAONIDÆ.

Subfamily I. Agaoninæ.

Kradibia brownii Ashmead; M. O.

Family LXI. TORYMIDÆ.

Subfamily I. Idarninæ.

Sycoryctes philippinensis Ashmead; M. O.
Philotrypesis ficicola Ashmead; M. O.

Subfamily IV. Podagrioninæ.

Podagrion philippinensis Ashmead; M. O.

Subfamily V. Megastigminæ.

Megastigmus immaculatus Ashmead; M. O.

Family LXII. CHALCIDIDÆ.

Subfamily I. Leucospidinæ.

Leucospis regalis Westwood.

Subfamily II. Chalcidinæ.

Chalcis albotibialis Ashmead; M. O.
argentifrons Ashmead; M. O.
banksi Ashmead; C. S. Banks.
obscurata Walker.
prodeniae Ashmead; M. O.
pulchripes Holmgren.
xerxena Walker.
Stomatocera sulcata Ashmead; M. O.
Arretocera stantoni Ashmead; M. O.
Neochalcis tarsalis Walker.
Haltichella ludlowae Ashmead; Miss C. S. Ludlow.
nasuta Holmgren.
validicornis Holmgren.
Dirhinus anthracia Walker.
auratus Ashmead; M. O.

Family LXIII. EURYTOMIDÆ.

Eurytoma albotibialis Ashmead; C. S. Banks.
banksi Ashmead; C. S. Banks.
carinatifrons Ashmead; M. O.
manilae Ashmead; M. O.
systolodes Ashmead; M. O.

Family LXV. EUCHARIDÆ.

Chalcura aegineta Walker.
nasua Walker.

Family LXVI. MISCOGASTERIDÆ.

Subfamily III. Miscogasterinæ.

Omerocerus pallidipes Ashmead; M. O.
Nesotoxeuma petiolata Ashmead; M. O.

Family LXVII. CLEONYMIDÆ.

Subfamily II. Cleonyminæ.

Epistenia ania Walker.
feretius Walker.

Family LXVIII. ENCYRTIDÆ.

Subfamily I. Eupelminæ.

Metapelma gloriosa Westwood.
Calosoter amenetus Walker.
Anastatus cyaneicollis Ashmead; M. O.
stantoni Ashmead; M. O.
Eupelmus albipes Ashmead; M. O.

Subfamily II. Encyrtinæ.

Taftia prodeniae Ashmead; M. O.
Howardiella tarsata Ashmead; M. O.
Ooencyrtus papilionis Ashmead; M. O.
Coccidencyrtus manilae Ashmead; M. O.
Aphidencyrtus pallidipes Ashmead; M. O.
Aphycus albiclavatus Ashmead; M. O.
Apterencyrtus pulchricornis Ashmead; M. O.
Exoristobia philippinensis Ashmead; M. O.

Family LXIX. PTEROMALIDÆ.

Subfamily IV. Spalangiinæ.

Nesospalangia aptera Ashmead; M. O.

Family LXX. ELASMIDÆ.

Elasmus philippinensis Ashmead; M. O.

Family LXXI. EULOPHIDÆ.

Subfamily I. Entedoninæ.

Closterocerus brownii Ashmead; M. O.
Asecodes elasmi Ashmead; M. O.

Subfamily II. Aphelininæ.

Aspidiotiphagus aleyrodis Ashmead; M. O.

Subfamily III. Tetrastichinæ.

Tetrastichus flavobasalis Ashmead; M. O.
philippinensis Ashmead; M. O.
Tetrastichoides brownii Ashmead; M. O.
manilensis Ashmead; M. O.
Ceranisus incertus Ashmead; M. O.
Gyrolasia tagala Ashmead; M. O.
Hyperteles flavipes Ashmead; M. O.

Subfamily IV. Elachertinæ.

Nesolynx flavipes Ashmead; M. O.
Euplectrus manilae Ashmead; M. O.
philippinensis Ashmead; M. O.

Superfamily VIII. ICHNEUMONOIDEA.

Family LXXIV. EVANIIDÆ.

Subfamily I. EVANIDINÆ.

Evania annulipes Ashmead; M. O.
appendigaster Linnaeus.
impressa Schletterer.
verrucosa Schletterer.

Family LXXVI. ICHNEUMONIDÆ.

Subfamily I. ICHNEUMONINÆ.

Tribe II. *Ichneumonini.*

Cratichneumon manilae Ashmead; M. O.
Elasmognatha cephalotes Ashmead; M. O.

Subfamily II. CRYPTINÆ.

Tribe II. *Phygadeuonini.*

Apsilops nigriceps Ashmead; M. O.
Isotima albicincta Ashmead; M. O.
albifrons Ashmead; M. O.
cincticornis Ashmead; M. O.

Tribe III. *Hemitelini.*

Chriodes oculatus Ashmead; M. O.
Strepsimallus bicinctus Ashmead; M. O.
Paraphylax fasciatipennis Ashmead; M. O.
flavus Ashmead; M. O.
Acanthohemiteles benjamini Ashmead; M. O.
Astomaspis metathoracica Ashmead; M. O.
Microcryptus praepes Bingham.
Otacustes alboannulus Ashmead; M. O.
Bathythrix striatus Ashmead; M. O.
Diatora prodeniae Ashmead; M. O.

Tribe VI. *Cryptini.*

Agrothereutes albicoxis Ashmead; M. O.
albipalpis Ashmead; M. O.
nigritarsis Ashmead; M. O.
unifasciatus Ashmead; M. O.
Agrothereutes verticalis Ashmead; M. O.
Chromocryptus albomaculatus Ashmead; M. O.

Tribe VII. *Mesostenini.*

Mesostenus leucozonatus Ashmead; M. O.
Mesostenoideus literatus Brullé.
octozonatus Ashmead; M. O.

Subfamily III. PIMPLINÆ.

Tribe III. *Lissonotini.*

Atropha clypearia Ashmead; M. O.
Amauromorpha metathoracica Ashmead; M. O.

Tribe IV. *Pimplini.*

Xanthopimpla kriegeri Ashmead; M. O.
Pimpla punctum Brullé.
Colpomeria flava Ashmead; M. O.

Tribe V. *Xoridini.*

Kriegeria heptazonata Ashmead; M. O.

Subfamily IV. TRYPHONINÆ.

Tribe X. *Metopini.*

Metopius browni Ashmead; M. O.

Subfamily V. OPHIONINÆ.

Tribe II. *Ophionini.*

Enicospilus ashbyi Ashmead; Ashby.
pacificus Ashmead; M. O.

Tribe IV. *Anomalini.*

Atrometus minutus Ashmead; M. O.

Tribe IVa. *Nesomesochorini.*

Nesomesochorus oculatus Ashmead; M. O.

Tribe V. *Campoplegini.*

Charops longiventris Ashmead; M. O.
papilionis Ashmead; M. O.

Tribe VIII. *Mesochorini.*

Mesochorus philippinensis Ashmead; M. O.

Tribe IX. *Porizonini.*

Leptopygus stangli Ashmead; P. L. Stangl.
Temelucha philippinensis Ashmead; M. O.

Tribe X. *Pristomerini.*

Pristomerus flavus Ashmead; M. O.

Family LXXVII. ALYSIIDÆ.

Subfamily II. ALYSIINÆ.

Tribe I. *Alysini.*

Aclisis pleuralis Ashmead; M. O.
Goniarcha malayensis Ashmead; M. O.

Tribe II. *Alloenini.*

Asobara försteri Ashmead; M. O.

Family LXXXVIII. BRACONIDÆ.

Subfamily IV. METEORINÆ.

Meteorus bacoorensis Ashmead; P. L. Stangl.
brownii Ashmead; M. O.

Subfamily V. MACROCENTRINÆ.

Tribe I. *Macrocentrini.*

Macrocentrus philippinensis Ashmead; M. O.

Subfamily VI. HELCONINÆ.

Tribe I. *Helconini.*

Euscelinus manilae Ashmead; M. O.
Cenocoelius albitarsis Ashmead; M. O.

Subfamily VIII. SIGALPHINÆ.

Fornicia annulipes Ashmead; M. O.

Subfamily IX. CHELONINÆ.

Chelonus albicinctus Ashmead; M. O.
semihyalinus Ashmead; M. O.
Phanerotoma albiscapa Ashmead; M. O.
philippinensis Ashmead; M. O.

Subfamily X. AGATHIDINÆ.

Tribe I. *Agathidini.*

Cremnops collaris Ashmead; M. O.

Tribe II. *Microdini.*

Stantonia flava Ashmead; M. O.

Subfamily XI. CARDIOCHILINÆ.

Cardiochiles philippinensis Ashmead; M. O.

Subfamily XII. MICROGASTERINÆ.

Glyptapanteles manilae Ashmead; M. O.
Apanteles manilae Ashmead; M. O.
philippinensis Ashmead; M. O.
Urogaster albinervis Ashmead; M. O.
opacus Ashmead; M. O.
philippinensis Ashmead; M. O.
stantoni Ashmead; M. O.
Microplitis manilae Ashmead; M. O.
philippinensis Ashmead; M. O.
Pseudapanteles agilis Ashmead; M. O.

Subfamily XIV. OPIINÆ.

Eurytenes nanus Ashmead; M. O.
Opius eurytenoides Ashmead; M. O.
deceptor Ashmead; M. O.
philippinensis Ashmead; M. O.
Biosteres longicaudatus Ashmead; M. O.

Subfamily BRACONINÆ.

Tribe II. *Braconini.*

Bracon alguéi Ashmead; M. O.
banksi Ashmead; Banks.
ricinicola Ashmead; M. O.
trisignatus Kirby.
vau Ashmead; M. O.

Microbracon luteipes Ashmead; M. O.
Habrobracon rugosiventris Ashmead; M. O.
Iphiaulax deceptor Smith.
luteifrons Brullé.
nigifrons Brullé.
Hemiglypus flavus Ashmead; M. O.

Tribe III. *Euurobraconini.*

Brownius armatus Ashmead; M. O.

Subfamily XVI. RHOGADINÆ.

Tribe II. *Rhyssalini.*

Rhyssalus unicolor Ashmead; M. O.

Tribe III. *Rhogadini.*

Rhogas melanosoma Ashmead; M. O.
pacificus Ashmead; M. O.

Tribe IV. *Doryctini.*

Ischiogonus philippinensis Ashmead; M. O.

Tribe V. *Hecabolini.*

Hecabolus ruficeps Ashmead; M. O.
rufrocinctus Ashmead; M. O.

Subfamily XVII. SPATHINÆ.

Tribe I. *Pambolini.*

Monolexis manilensis Ashmead; M. O.

Tribe III. *Spathiini.*

Spathius fuscipennis Ashmead; M. O.
philippinensis Ashmead; M. O.

Family LXXIX. STEPHANIDÆ.

Stephanus coronator Fabricius.
indicus Westwood.
nigricaudatus Sichel.
sulcifrons Schletterer.
tarsatus Schletterer.
unicolor Sichel.

Suborder II. **Phytophaga** Ashmead.

Superfamily IX. SIRICOIDEA.

Family LXX. ORYSSIDÆ.

Oryssus maculipennis Smith.

Family LXXXI. SIRICIDÆ.

Tremex nigricollis Westwood.

Superfamily X. SELANDRIIDÆ.

Paraselandria imitatrix Ashmead; M. O.
Senoclia albocoerulea Bingham.

SOME OF THE PHILIPPINE HYMENOPTERA BRED IN THE MANILA OBSERVATORY, WITH HOSTS.

1. HYMENOPTERA.

PARASITES.	HOSTS.
Sycorytes philippinensis Ashm.	Kradibia brownii Ashm.
Philicrypesis ficicola Ashm.	Kradibia brownii Ashm.
Closterocerus brownii Ashm.	Euplectrus manilae Ashm.
Nesolynx flavipes Ashm.	Microplitis philippinensis Ashm.
Asecodes elasmi Ashm.	Elasmus philippinensis Ashm.

2. DIPTERA.

Anopedias luzonicus Ashm.	Lasioptera sp.
Exoristobia philippinensis Ashm.	Exorista dispar.

3. LEPIDOPTERA.

Parasites.	Hosts.
Chalcis albotibialis Ashm.	Erionota thrax Linn.
Chalcis banksi Ashm.	Ticera castanea Sevinhoe.
Chalcis prodeniae Ashm.	Prodenia sp.
Anastatus stantoni Ashm.	Padraona chrisozona Plotz.
Eurytoma manilae Ashm.	Eggs of Attacus atlas Linn.
Taftia prodeniae Ashm.	Prodenia littoralis Boisd.
Ooencyrtus papilionis Ashm.	Eggs of Papilio alphenor Cram.
Coccidencyrtus manilae Ashm.	Plusia eriosoma Doubl.
Exoristobia philippinensis Ashm.	Orgyia postica Walk.
Euplectrus manilae Ashm.	Papilio alphenor Cram.
Euplectrus philippinensis Ashm.	Eucleid sp.
Charops longiventris Ashm.	Papilio rumanzovia Esch.
Charops papilionis Ashm.	Papilio agamemnon Linn.
Meteorus brownii Ashm.	Noctuid sp.
Apanteles philippinensis Ashm.	Plusia eriosoma Doubl.
Apanteles stantoni Ashm.	Pieris ida Cram.
Urogaster philippinensis Ashm.	Parasa lorquinii Reak.
Urogaster stantoni Ashm.	Tortricid sp.
Microplitis manilae Ashm.	Prodenia littoralis Boisd.
Microplitis philippinensis Ashm.	Melopsilus acteus Cram. Chaerocampa oldenlandiae Fab.
Rhyssalus unicolor Ashm.	Tineid sp.

4. HEMIPTERA.

Hadronotus philippinensis Ashm.	Eggs of Leptoglossus membranaceus Fabr.
Telenomus catacantha Ashm.	Catacanthus cerrenoi Le Guillon.
Aspidiotiphagus aleyrodis Ashm.	Aleyrodes sp.

NOTES ON BIRDS COLLECTED IN MINDORO AND IN SMALL ADJACENT ISLANDS.

By Richard C. McGregor.

(*From the Zoölogical Section of the Biological Laboratory, Bureau of Science.*)

I am indebted to Dr. E. H. Porter, contract surgeon, United States Army, for permission to publish the following lists of birds which are based upon collections made by him in the vicinity of Bulalacao, Mindoro, and on the small Islands of Sibay, Caluya, Libagao, and Semirara, off the southeast coast of Mindoro. A few species are recorded from Tambaron, but as this island is very small and but 5 miles off the coast of Mindoro near Bulalacao, it does not seem necessary to deal with it separately.

Dr. Porter was stationed at Bulalacao from May 19, 1905, to February 24, 1906, and most of his specimens were obtained in the vicinity of that town. No visits were made to the higher mountains of Mindoro and information concerning the birds of the smaller islands was gained during short visits to them.

The collection contains specimens of all the species hereinafter recorded in the list of species collected and all of the new records for Mindoro are based upon skins examined by me. For the lists of species from the small islands (Semirara, Caluya, Sibay, Libagao) I have, in most instances, depended upon the field identification made by Dr. Porter, as these species can be easily named on sight.

The ultimate destination of this collection is not known to me, but as Dr. Porter has taken it to the United States it will probably find its way into some one of the larger museums in that country.

The Hand-List, referred to in the text and footnotes, is that by McGregor and Worcester,[1] issued January, 1906.

The sequence of genera and the nomenclature of the present paper are the same as in that publication.

Dr. Porter obtained specimens of thirteen species not hitherto recorded from Mindoro; their points of interest are mentioned in the list of species collected.

[1] *Publications of the Bureau of Government Laboratories* (now Bureau of Science), **36.**

LIST OF SPECIES NEW TO MINDORO.

Rallina fasciata.
Sterna boreotis.
Ochthodromus mongolus.
Ægialitis peroni.
Totanus eurhinus.
Ardea sumatrana.
Egretta garzetta.
Spizaëtus philippensis.
Hirundo striolata.
Oreocichla varia.
Locustella fasciolata.
Munia cabanisi.
Uroloncha everetti.

On Semirara [2] two species were seen, viz:

Cacomantis merulinus.
Cinnyris jugularis.

For the Island of Caluya Dr. Porter furnishes a list of twenty-two species; of the most interesting bird, *Zosterops,* but a single specimen was killed.

LIST OF SPECIES NOTED ON CALUYA.

Streptopelia dussumieri.
Sterna boreotis.
Nycticorax manillensis.
Tanygnathus lucionensis.
Halycon gularis.
Halycon chloris.
Cacomantis merulinus.
Eudynamis mindanensis.
Hemichelidon griseisticta.
Hypothymis occipitalis.
Lalage niger.
Pycnonotus goiavier.
Cisticola exilis.
Acanthopneuste borealis.
Artamus leucorhynchus.
Otomela lucionensis.
Zosterops sp.
Cinnyris jugularis.
Oriolus chinensis.
Sarcops calvus.
Lamprocorax panayensis.
Corone philippina.

Nine common species were observed on Sibay.

LIST OF SPECIES NOTED ON SIBAY.

Osmotreron axillaris.
Osmotreron vernans.
Halycon gularis.
Halycon chloris.
Cacomantis merulinus.
Artamus leucorhynchus.
Otomela lucionensis.
Oriolus chinensis.
Sarcops calvus.

Ten species were seen and identified on Libagao, but the only one of value is unrepresented by skins, so that its identity is open to question.

LIST OF SPECIES NOTED ON LIBAGAO.

Streptopelia dussumieri.
Eurystomus orientalis.
Halycon gularis.
Halycon chloris.
Artamides mindorensis?
Pycnonotus goiavier.
Oriolus chinensis.
Sarcops calvus.
Lamprocorax panayensis.
Corone philippina.

[2] For previous lists of birds from Semirara and Sibay, see McGregor, *Publications of the Bureau of Government Laboratories* (1905), 34, 25–27.

LIST OF SPECIES COLLECTED.

Megapodius cumingi Dillw.
Bulalacao.

Excalfactoria lineata (Scop.).
Bulalacao.

Gallus gallus (Linn.).
Bulalacao.

Turnix fasciata (Temm.).
One female from Bulalacao, May, 1905.

Osmotreron axillaris (Bp.).
From Bulalacao and Sibay; the latter locality is a new one for this species.

Osmotreron vernans (Linn.).
Bulalacao and Sibay; the species has not been recorded before from Sibay.

Phapitreron leucotis (Temm.).
Bulalacao.

Leucotreron leclancheri (Bp.).
A specimen from Bulalacao, where the species is rare.

Muscadivora ænea (Linn.).
Abundant at Bulalacao.

Ptilocolpa carola (Bp.).
Bulalacao.

Myristicivora bicolor (Scop.).
Bulalacao.

Macropygia tenuirostris (Bp.).
Bulalacao.

Streptopelia dussumieri (Temm.).
Abundant in the vicinity of Bulalacao and observed on the Islands of Caluya and Libagao; this is the first notice of the species on these two small islands.

Chalcophaps indica Gould.
Not uñcommon near Bulalacao.

Hypotænidia striata (Linn.).
At Bulalacao an adult female of this rail was taken December 7, and an immature female was taken December 22, 1905.

Rallina fasciata (Raffl.).
A male of this rail, taken in May, 1905, near Bulalacao, makes an addition to the list of Mindoro species.

Rallina euryzonoides (Lafr.).
A female specimen from Bulalacao, May, 1905, is similar to one of the same sex from Cagayancillo, except that the tarsi and wings are longer.

Poliolimnas cinereus (Vieill).
A male was taken at Bulalacao, January 19, 1906.

Sterna boreotis (Bangs).
This tern was common at Bulalacao where specimens were collected; it was also observed about Caluya and the small Island of Tambaron. The species seems to be unrecorded from both Mindoro and Caluya.

Ochthodromus geoffroyi (Wagl.).
A male from Bulalacao, October 30, 1905, and a male from Tambaron, January, 1906; small shore birds were particularly abundant along the beach on Tambaron.

Ochthodromus mongolus (Pall.).

A female was taken on Tambaron, January 28, 1906; the species has not been previously recorded from Mindoro.

Ægialitis peroni (Bp.).

A female in winter plumage was taken on Tambaron, January 28, 1906; this is the first time the species has been noted for Mindoro.

Totanus eurhinus (Oberh.).

The redshank is now recorded from Mindoro for the first time on the strength of a male taken at Bulalacao November 29, 1905.

Actitis hypoleucus (Linn.).

A female from Bulalacao, January 25, 1906.

Ardea sumatrana Raffl.

A large heron in immature plumage, taken at Bulalacao, appears to belong to this species, which has been recorded in the Philippines from Palawan and Negros. The present specimen yields the following measurements: Culmen, 6.5 inches; tarsus, 6.5; tail, 7.6.

Egretta garzetta (Linn.).

A male was taken near Bulalacao, January 1, 1906; I have seen birds, probably of this species, near Calapan, but the present specimen seems to be the first to be recorded from Mindoro.

Nycticorax manillensis Vig.

Two specimens of the Manila night heron were taken on Caluya, from which island it was not previously known, December 10, 1905.

Butorides javanica (Horsf.).

Bulalacao.

Ardetta cinnamomea (Gm.).

Bulalacao.

Anhinga melanogaster (Pennant).

Common near Bulalacao.

Sula sula (Linn.).

An adult female of the common booby was taken on board ship some 300 miles from San Bernardino Straits; approximate position, 15° north, 130° east.

Accipiter manillensis (Meyen).

A small *Accipiter* from Bulalacao is most probably of the above species.

Spizaëtus philippensis Gurney.

One adult from Bulalacao; not previously recorded from Mindoro.

Spilornis holospilus (Vig.).

Bulalacao.

Butastur indicus (Gm.).

Bulalacao.

Haliaëtus leucogaster (Gm.).

One adult bird from Bulalacao; another bird of about the same size is doubtfully identified as the young of this species; its tail, however, is much longer than in adult *H. leucogaster*.

Haliastur intermedius Gurney.

Bulalacao.

Elanus hypoleucus Gould.

One specimen from Bulalacao.

Microhierax erythrogenys (Vig.).

Two specimens from Bulalacao.

Cerchneis.?

A specimen of a hawk, possibly a *Cerchneis*, was collected in Mindoro by Dr. Porter. From the literature at hand, I have been unable to identify it and must leave its name to be recorded in a future paper.

Ninox mindorensis Grant.

Two males and a female from Bulalacao do not differ from specimens collected by me on the Rio Bacō, Mindoro; two are in the light phase and the third is lightly washed with rufous on the under parts. Dr. Porter found the species common in the vicinity of Bulalacao.

Prioniturus mindorensis Steere.

Bulalacao.

Tanygnathus lucionensis (Linn.).

Bulalacao in Mindoro and Caluya; the latter island is a new locality for this species.

Loriculus mindorensis Steere.

Bulalacao.

Eurystomus orientalis (Linn.).

Bulalacao; the species was also seen on Libagao, which is a new locality for it.

Pelargopsis gouldi Sharpe.

Bulalacao.

Alcedo bengalensis Briss.

Bulalacao.

Halcyon gularis (Kuhl).

Halcyon chloris (Bodd.).

These two common kingfishers were obtained at Bulalacao in Mindoro and were also noted on Sibay, Libagao, and Caluya.

Penelopides mindorensis Steere.

Bulalacao.

Merops americanus P. L. S. Müller.

Abundant at Bulalacao.

Lyncornis macrotis (Vig.).

Several specimens of this fine goatsucker were taken at Bulalacao and one was killed at Pola on the northeast coast of Mindoro.

Caprimulgus griseatus Wald.

Caprimulgus manillensis Wald.

Specimens of each of the above species were taken at Bulalacao.

Macropteryx major Hartert.

One specimen from Bulalacao.

Salangana whiteheadi (Grant).

A single female swift from Bulalacao is most probably of this species, but its somewhat bad condition prevents exact determination.

Salangana linchi (Horsf. and Moore).

One specimen from Bulalacao.

Salangana marginata (Salvad.).

Dr. Porter states that this species was abundant at Bulalacao, where he took several specimens.

Hierococcyx fugax (Horsf.).

A male from Bulalacao, taken in May.

Cacomantis merulinus (Scop.).
This common cuckoo was obtained at Bulalacao and was also noted on the Islands of Caluya, Sibay, and Semirara.

Chacococcyx xanthorhynchus (Horsf.).
One specimen from Bulalacao.

Eudynamis mindanensis (Linn.).
A female was taken on Caluya, December 10, 1905.

Centropus mindorensis Steere.
A female cuckoo, probably of this species, taken at Bulalacao, May 18, 1905, has the entire plumage creamy-white, the crown a trifle dusky. Dr. Porter tells me that when collecting in the Camarines Provinces, Luzon, in 1902 he took another white cuckoo.

Centropus javanicus (Dumont).
Bulalacao.

Xantholæma hæmatocephalum (P. L. S. Müller).
A young bird from Bulalacao, taken in May.

Yungipicus validirostris (Blyth).
Bulalacao.

Thriponax mindorensis Steere.
Three specimens were obtained at Bulalacao.

Pitta erythrogaster Temm.

Pitta atricapilla Less.
These two common ground-thrushes were obtained at Bulalacao.

Hirundo javanica Sparrm.
One male from Bulalacao.

Hirundo striolata (Boie).
A young male from Bulalacao taken October 26 is exactly like a young bird taken by me in Calayan, November 1, 1903. This is the first record of the species for Mindoro.

Hemichelidon griseisticta (Swinh.).
A female was taken on Caluya, December 10.

Cyornis philippinensis Sharpe.
Bulalacao.

Hypothymis occipitalis (Vig.).
Specimens from Bulalacao; the species was also observed on Caluya.

Rhipidura nigritorquis Vig.
Bulalacao.

Artamides mindorensis Steere.
Specimens from Bulalacao; Dr. Porter saw birds on Libagao which were probably of this species.

Pericrocotus cinereus Lafr.
One specimen of this migratory minivet was taken at Bulalacao, November 7.

Lalage niger (Forster).
This species was obtained at Bulalacao and observed on the Island of Caluya.

Iole mindorensis Steere.
Bulalacao.

Pycnonotus goiavier (Scop.).
Bulalacao; also observed on Libagao and Caluya.

Oreocichla varia (Pall.).

A male of White's thrush was obtained at Bulalacao, December 7, 1905. This is the most interesting bird in the present collection, as the only previous Philippine specimens are those noted by Tweeddale[3] from "the vicinity of Manilla" and those collected by Whitehead in Lepanto, Luzon, at 6,000 to 8,000 feet elevation.[4]

Petrophila manilla Bodd.

Bulalacao.

Calliope calliope (Pall.).

One specimen from Bulalacao, January 1, 1906; one other was seen.

Copsychus mindanensis (Gm.).

Taken at Bulalacao and on the little Island of Tambaron.

Pratincola caprata (Linn.).

Rare at Bulalacao, where one specimen was killed.

Locustella fasciolata (Gray).

A male in yellowish plumage was taken at Bulalacao, October 15; although the specimen is in poor condition, having been badly shot, I have no hesitation in referring it to the above species which is now recorded from Mindoro for the first time.

Cisticola exilis (Vig. and Horsf.).

Specimens were taken at Bulalacao and the species was seen on Caluya.

Acanthopneuste borealis (Blas.).

Several specimens of this common migrant taken at Bulalacao in November; it was also seen on Caluya and Tambaron.

Artamus leucorhynchus (Linn.).

This swallow-shrike was obtained at Bulalacao and was seen on Sibay and Caluya.

Cephalophoneus nasutus (Scop.).

A male specimen of this shrike was taken at Bulalacao, February 2.

Otomela lucionensis (Linn.).

Taken at Bulalacao; also seen on Sibay and Caluya.

Zosterops sp.

A single female *Zosterops* taken on Caluya, December 10, 1905, can not be determined from the material at hand; it is closely related to *Z. richmondi* of Cagayancillo as well as to *Z. aureiloris* of Luzon and Mindoro.

Dicæum papuense (Gmel.).

Bulalacao.

Prionochilus inexpectatus Hartert.

One specimen from Bulalacao.

Piprisoma æruginosum (B. & W.).

Six specimens were taken near Bulalacao.

Cinnyris jugularis (Linn.).

A young male was taken on Caluya and adults were taken at Bulalacao; the species was also seen on Semirara.

Motacilla melanope Pall.

Budytes leucostriatus Hom.

These two wagtails were killed at Bulalacao.

[3] *P. Z. S.* (1878), 429.

[4] *Ibis* (1899), **5**, 212.

Anthus rufulus Vieill.
Bulalacao.

Anthus gustavi Swinh.
A male from Bulalacao, October 21.

Munia jagori Martens.
A young female from Bulalacao, October 7.

Munia cabanisi Sharpe.
In a young bird taken at Bulalacao, January 20, the under parts are light drab brown, a few feathers on the flanks and under tail coverts with the characteristic markings of the adult plumage; upper parts earthy brown; edges of rectrices washed with green. A young male of January 10 is somewhat similar in color and has indications of the reddish-brown chin patch. This species is an addition to the list of Mindoro birds.

Uroloncha everetti (Tweedd.).
This is another species of weaver finch added to the Mindoro list by Dr. Porter, who took a specimen at Bulalacao on December 10.

Oriolus chinensis Linn.
Obtained at Bulalacao and seen on Caluya, Libagao, and Sibay.

Dicrurus balicassius (Linn.).
Bulalacao.

Sturnia philippensis (Forster).
Specimen collected in the vicinity of Bulalacao.

Sarcops calvus Linn.
Collected at Bulalacao and seen on Caluya, Libagao, and Sibay.

Lamprocorax panayensis (Scop.).
Abundant at Bulalacao; also noted on Caluya and Libagao.

Corone philippina (Bonap.).
Numerous specimens from Bulalacao; also seen on Caluya and Libagao.

Corvus pusillus Tweedd.
A number of specimens taken at Bulalacao.

REVIEWS.

The Practice of Medicine. A text-book for practitioners and students with special reference to diagnosis and treatment. By James Tyson, M. D. Fourth edition, revised and enlarged, with 240 illustrations, including colored plates. Cl., pp. 1305. Price, $5.50 net. Philadelphia: P. Blakiston's Son & Co. 1906.

On the whole Dr. Tyson has given us a splendid book and the value of this last addition is much enhanced by Dr. Smith's excellent chapter on animal parasites and the conditions caused by them.

Diabetes, typhoid fever and a number of other diseases of which the author has long been known as a careful student have received a most thorough and satisfying consideration.

All discussions as to treatment are carefully revised and thorough; the positiveness with which drugs are recommended and the careful details for their administration will do much to retain fast-disappearing optimism in this branch of therapeutics.

One is somewhat surprised that the paratyphoid fevers should receive such brief consideration and the discussion of some other diseases such as Malta fever, amœbic dysentery, dengue, and even malaria, is hardly satisfying, at least to those working with these infections in the Tropics.

It would seem that the recent literature on smallpox, splenic anemia, splenomegalies in general, arterioschlerosis, and several other diseases is of sufficient importance to give more of it attention in a book of this character, revised as it is to 1906.

W. E. M.

Nothnagel's Encyclopedia of Practical Medicine: Malaria, Influenza, and Dengue. By Dr. Julius Mannaberg and Dr. O. Leichtenstern. Edited with additions by Major Ronald Ross, F. R. C. S., F. R. S., C. B.; J. W. W. Stephens, M. D., D. P. H., and Albert S. Grünbaum, M. D., F. R. C. P. Translated from the German under the editorial supervision of Alfred Stangel, M. D.—Cl., pp. 769. W. B. Saunders & Company, Philadelphia and London, 1905.

The volume of Nothnagel's Practice dealing with malaria, influenza, and dengue, is of peculiar interest to the student of tropical medicine by reason of the wide distribution and importance of the first of the diseases treated and because of the uncertainty of the nature and symptomatology of that disease so exclusively diagnosed in the Tropics, namely, dengue.

In connection with the section on the etiology of malaria it is observed, under the head of methods of examination, that after giving in detail steps for making unstained preparations, the statement is made that if by reason of not having a microscope at hand or for any other cause it is deemed advisable, dry preparations may be made and stained. This attitude in almost all text-books on the subject of malaria, which would appear to advocate the choosing of either the stained or unstained preparation, is unfortunate—it is as if two rival methods were presented and a choice had to be made between them. In distinguishing the different kinds of parasites, there is so much to be learned from a study of both unstained and stained specimens that it would seem advisable strongly to impress upon everyone who takes up the subject to employ both methods. While waiting for the completion of the staining, the observer has a few minutes which can profitably and without loss of time be devoted to the fresh blood and then later, the stained smear can be studied with greater facility by reason of the information gained from the unstained preparation. Especially as regards differentiating young forms, there would seem to be no question as to the advantage of the stained over the unstained preparation.

The Romanowsky-Zieman stain is greatly praised by the editor and it is certainly most excellent. However, it has the same objection which obtains to the well-known Leishman and Wright stains, of not keeping well in the Tropics. When polychroming is done by precipitating silver nitrate, as in Borrel's blue, a much more permanent stain for the Tropics is made than is the case where sodium carbonate or bicarbonate is employed.

In view of the general tendency among those capable of speaking authoritatively, to consider simply three forms of malaria, it would appear unfortunate that in a work so influential it was deemed advisable to multiply the different species. The propriety of dividing the parasites, the sexual form of which is manifested in crescents, into three classes is certainly questionable and it is at least an unfortunate complication for the novice in the study of malaria.

In the excellent chapter on malaria in its relation to the mosquito, in the paragraph on differentiation of species will be found a concise and comprehensive consideration of the points to be observed in examining *Anophelinæ* and the confusion which may arise from attributing too much importance to spots or attaching weight to the position of the cross veins is clearly indicated.

Under the genus *Myzomyia* the same view is adopted as is given in Theobald's monograph, namely, that *M. ludlowii* Theob., is probably not a distinct species, but only a variety of *M. rossii* Giles. An examination of a large number of this common malarial mosquito of the Philippines shows the constant presence of the characteristics presented by *M. ludlowii* Theob., and its difference from *M. rossii* Giles so that it would appear to

have greater claim to the distinction of a separate species than is the case with many other ones of *Anophelinæ*.

Were it not that we have in the finding of the parasite in the blood a method of diagnosing æstivo-autumnal fever which rarely fails one who has experience, the multiplicity of varying manifestations of this type of malaria, as it is discussed in the chapter on perniciousness, would cause one forever to despair of diagnosing pernicious malaria from an endless number of other more or less serious conditions. The article is of value because it shows the possibilities of pernicious malaria, but it certainly is confusing. Again, were quinine given hypodermically immediately after the microscopical diagnosis is made, it is believed that these pernicious types would lose in importance.

In carefully reading over the portion of the book treating of influenza, it is impossible for one familiar with dengue not to be constantly asking himself whether by any possibility these two diseases may not be identical. It is an easy matter in the comparatively mild cases of dengue, where the eruption is abundant and after a typical differential count of the white blood corpuscles, to feel reasonably sure that we are dealing with a separate disease, but when we have in mind those cases, usually considered as dengue, where the nervous manifestations are most pronounced—particularly the intense depression—and where the eruption and the count of the leucocytes have little which is characteristic, it would seem to be only a distinction in name between this form of dengue and influenza. Consequently, viewed in this light, the three-page table of epidemiological and clinical differences between influenza and dengue would appear to be superfluous.

E. R. S.